Health concerns related to housing, sanitation, water access and waste disposal in a poor mixed urban community, Mbekweni in Paarl

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Abstract

South Africa's rapid population growth and fast in-migration into already densely populated urban areas are placing great strain on municipal services. Numerous municipalities outside the major cities are not able to provide adequate infrastructure or safe standards of basic services in these low-income areas. In urban poor communities, the sustainable management of recovery or recycling of waste is carried out poorly or not at all. Hygiene, sanitation, and proper waste disposal are of great concern to both the public and the environment. Poor waste management leads to the degradation of the environment and poor sanitation results in the spread of communicable diseases. This study aimed to investigate the degree to which human behaviour results in direct and/or indirect health risks for a low-income community with mixed informal and semiformal housing. The impact on the immediate environment is also investigated. The problems facing such communities outside of the main cities are not well researched.

A cross-sectional survey that covered topics of demography, housing, waste and waste disposal, health and hygiene features was designed. The survey targeted residents living in informal settlements in Mbekweni as well as low-income houses. Systemic sampling with random starting points was used to collect the necessary data. A total of 117 structures representing 512 inhabitants were investigated and a series of water samples was collected at various location points near the residences in order to assess the level of environmental pollution.

Forty-eight percent of the respondents lived in shacks, while 52% lived in brick-and-mortar houses. The whole community can be classified as falling into the low-income bracket with households receiving an average monthly income of R3736. Findings also showed that 45% of the community had to make use of communal toilets and taps, many of which were not fully functional. Nineteen percent of the participants reported gastrointestinal symptoms during the survey, 10% possible TB symptoms and 9% other infections. The *E. coli* counts detected in the environmental water samples varied from 2300 organisms to 32 million organisms per 100 ml water, indicating extensive sewage contamination.

In this indigent community, the study found poor waste disposal behaviour, poorly maintained sanitation facilities resulting in high levels of environmental pollution. Such factors are linked to high risks of infectious diseases in the community. The study found that the community had little knowledge concerning the ways in which they can be involved in minimizing the spread of communicable diseases and keeping their community clean. The study participants

displayed an adequate basic knowledge of home hygiene. The qualitative assessment of their domestic sanitation and hygiene however did not reflect that knowledge. There is an urgent need for reform of basic service delivery to such communities as well as education to improve their sanitation approach.

Opsomming

Suid-Afrika se vinnig groeiende bevolking en vinnige inmigrasie na reeds dig bevolkte dorpsgebiede plaas groot druk op munisipale dienste. Baie munisipaliteite buite die groot stede kan gevolglik nie infrastruktuur behoorlik instandhou of dienste lewer in lae-inkomste gebiede nie. In arm dorpsgemeenskappe vind volhoubare bestuur van hergebruik of herwinning van afval swak of selfs glad nie plaas nie. Higiëne, sanitasie en behoorlike wegdoening van afval is belangrik vir die gemeenskap en die omgewing. Swak afvalbestuur lei tot die beskadiging van die omgewing en swak sanitasie lei tot die verspreiding van aansteeklike siektes. Die doel van hierdie studie is om te ondersoek in watter mate inwoners se optrede 'n direkte en/of indirekte invloed het op menslike gesondheid in 'n lae-inkomste woongebied met informele en formele wooneenhede. Die probleme in sulke gemeenskappe buite die groot stede is nie goed nagevors nie.

'n Dwarsdeursnit opname is ontwerp wat aspekte soos demografie, huisvesting, afval en wegdoening, gesondheid en higiëne insluit. Die inligting is ingesamel by inwoners van informele strukture asook lae-inkomste behuising in Mbekweni. 'n Stelselmatige steekproef met ewekansige beginpunte is gebruik om die data te versamel. 'n Totaal van 117 strukture met 512 inwoners is ondersoek en 'n reeks watermonsters is geneem by verskillende punte naby die wonings om 'n beeld te kry van die mate van omgewingsbesoedeling.

Ag-en-veertig persent van die deelnemers het in informele (krot) huise gewoon en 52% in baksteenhuise. Die hele gemeenskap kan as behoeftig beskou word, met huishoudings wat 'n gemiddelde maandelikse inkomste van R3736 ontvang. Bevindings dui daarop dat 45% van inwoners gemeenskaplike toilette en krane gebruik, waarvan baie nie funksioneel was nie. Neëntien persent van die deelnemers het gastroïntestinale simptome aangemeld terwyl 10% moontlike TB simptome en 9% ander infeksiesimptome aangemeld het. Die *E. coli* tellings in die watermonsters vanaf die omgewing het gewissel vanaf 2300 tot 32 miljoen organismes per 100 ml water. Dit dui op uitgebreide besmetting met riool.

In hierdie arm gemeenskap is swak gedrag ten opsigte van afvalwegdoening gevind asook sanitasiestelsels wat swak onderhou word en wat tot hoë vlakke van omgewingsbesoedeling gelei het. Sulke faktore hou verband met hoë risikos van infektiewe siektes in so 'n gemeenskap. Die studie het ook gevind dat die gemeenskap min kennis het van die maniere waarop hulle self betrokke kan raak om die verspreiding van aansteeklike siektes te bekamp en hoe om hulle omgewing skoon te hou. Die deelnemers het ‘n basisese kennis van huishoudelike higiëne getoon, maar die kwalitatiewe beoordeling van hulle huishoudelike sanitasie en higiëne het

nie daardie kennis weerspieël nie. Daar is 'n ernstige behoefte aan hervorming van basiese dienslewering aan sulke gemeenskappe sowel as aan opvoeding om hulle sanitasiegedrag te verbeter.

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List of abbreviations

AIDS	Acquired Immunodeficiency Syndrome
CWD	Cape Winelands District
DEAT	Department of Environmental Affairs and Tourism
E. coli	*Escherichia coli*
FPL	Food Poverty Line
HCW	Health-care waste
HIV	Human Immunodeficiency Virus
LBPL	Lower Bound Poverty Line
LRTI	Lower respiratory tract infection
MSW	Municipal solid waste
NEMWA	National Environmental Management Waste Act
NWMS	National Waste Management Strategy
RDP	Reconstruction and Development Programme (RDP)
SEP	Socio-Economic Profile
TB	Tuberculosis
UBPL	Upper Bound Poverty Line
UN	United Nation
WHO	World Health Organisation

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CHAPTER 1

Literature review

1.1 Background

Urbanization is widespread and it is expected that in the year 2030 more than half of Africa's population will dwell in urban areas.[1] Urbanization has brought many positive health improvements to those relocating but also shifts in disease patterns such as an increase in chronic illnesses (cancer, diabetes, cardiovascular diseases, etc.).[2] In low-income countries it has been reported that the economic growth struggles to keep up with the increase in urban populations while residents face many constraints, the main challenge being access to adequate housing conditions (access to adequate drinking water, sanitation and basic hygiene).[2] Rapid and unplanned urbanization has resulted in increasing poor living conditions. The municipal authorities are not able to respond to the growing demands for basic human needs as visible from the streets littered with waste and blocked drains.[3] Low-income countries are still at a disadvantage when considering the shift in disease patterns from developed countries, unlike developed countries, infectious diseases is still the leading cause of mortality and morbidity.[2] Public health remains a core issue when dealing with such populations.

1.2 Urbanisation and poverty

Eliminating poverty is a social, political, ethical and economic necessity for humanity.[4] It is estimated that approximately 1.2 billion of the world's population live in extreme poverty,[5] and many rely on degraded ecosystems.[6] The indigent live in overcrowded, unsafe, environments that weaken their immune systems and continually perpetuate ill-health.[5] People exposed to poverty reside in improper shelters that lack or have minimal access to clean water or suitable sanitation.[5] Children are the ones who suffers most from poverty.[7] Poverty creates an environment that hinders the mental, spiritual, physical as well as emotional growth of a child.[7] In developing countries, poverty plays a role in malnutrition, and malnutrition has been a contributing factor to the mortality of children under the age of five.[7] Children who are malnourished are more prone to diseases caused by poor sanitation.[7]

In 2012 the South African government implemented the use of "three national poverty lines for the measurement and monitoring of money-metric poverty in the country".[8] These poverty lines are essential tools used to observe the poverty levels and patterns in a country and provides a statistical overview so that strategies can be set in place to reduce poverty.[9] The National Poverty lines for South Africa as provided by Stats SA are; the Food Poverty Line (FPL), the Lower Bound Poverty Line (LBPL) and the Upper Bound Poverty Line (UBPL)".[8] As of April 2018, Stats SA reported the FPL, LBPL and UBPL to be R547, R785 and 1183 per-person-per-month respectively.[9] In 2015 South Africa experienced a rise in poverty levels and more than half of the population was estimated to be in a state of poverty, a poverty headcount increase of 55.5%.[10] Reports from the Living Condition Survey of 2014/15 of South Africa found that 20.6% of the adult population were living under the FPL, while 33.8% of the population were under the LBPL and an estimated 49.2% of the population fell under the UBPL.[11] It is worth noting that women in South Africa poorer than the males as statistics documented a poverty headcount of 58.6% for the women compared to the 54.9% documented for the males.[12] In the Western Cape province the poverty headcount was 33.2% of the adult population living in poverty.[13] [11]

Poverty can be viewed in a broad or narrow scope. In the broader scope poverty includes issues such as health, housing, education and access to service delivery.[14] One important dimension of poverty that has received attention, not only in South Africa, but also on a global scale, is the degree in which poverty is a persistent condition, thus to what magnitude are individuals or households stuck in a condition of poverty over time.[15] Chronic poverty is a term used to describe the transmission of poverty over generations.[15] This therefore means that children born in poor households are most likely going to grow up being poor adults whose future children are at risk of continuing the poverty cycle.[15] The question of poverty being an intergenerational aspect in South Africa is complicated by the historical background of our country.[15]

Wealth and poverty usually determines numerous aspects of our daily social life.[16] Low-income communities are usually characterised by lower standards of educational facilities, inadequate housing conditions, inadequate drinking water supply, unhygienic conditions, poor health and nutrition as well as neglected health facilities.[17] Poverty has been observed as having the lack of freedom to lead the life an individual can value, for example studies have demonstrated that people in low-income countries seldom prepare for their retirement, have a less healthy diet,

and rarely exercise as compared to the individuals of wealthier countries.[16] In South Africa children are too often dying from preventable diseases such as pneumonia, HIV, TB, and diarrhoea. These diseases are related to "poor health seeking behaviour, health care, infectious diseases, nutrition and hygiene of the pregnant mother and child during the first 1000 days of life".[18]

People who are poor live with the perception that they are "cripples and that their lives are horrible, therefore no one needs them".[19] People living in poor conditions are in a "psychological state of fear and they tend to believe that they are dependent on others for survival and that the rest of the world does not require them". [19] Studies have shown that an individual's place in society impacts health and long life.[16,17,18] Poverty is therefore the inability of an individual to live a life that promotes good health.

1.3 Housing in poor urban communities

1.3.1 The effects of urbanization on a global scale

All over the world rapid urbanization is taking place and it is expected that by 2050, 72% of the world will be urbanized.[20] Challenges of urbanization are particularly apparent in developing countries and it is estimated that by 2030 60% of the population of the developing countries will reside in towns and cities. [20] A rapid urbanization in developing countries is often accompanied by urban poverty. [20] Urbanization in low and middle-income countries can have both positive and negative effect for the inhabitants.[21] On the negative side, the growing concentration of the population and the shortage of financial resources and inadequate institutional capabilities presents a rise in poverty, insecurity, instability and environmental degradation.[21] It is vital for a community to have access to safe water supply and proper sanitation facilities to preserve the dignity and health of the people.[22] In developing countries however there is a shortage in houses that fulfil these needs.[23] Individuals with low incomes tends to have poor housing and often struggle to maintain their living conditions.[24] Poor housing affects the basic human needs in various ways, such as inadequate drinking water, sanitation and hygiene, safe food preparation, all of which are factors that contribute to communicable food-borne, water-borne and air-bone diseases.[25]

1.3.2 Housing in South Africa

South Africa is a middle-income country that is known as the largest economy on the African continent.[26] It however has a long history of insufficient and unsatisfactory housing for low-income communities living in dense and poorly maintained informal settlements on the urban periphery.[27] Housing continues to be a persistent infrastructure shortcoming in South Africa and other developing countries and this problem is further fuelled by urbanization which results in the increase of slums and informal settlements.[28] Poverty exists all over South Africa and with that; there is clear evidence of high unemployment and a serious shortage of formal housing.[28] The Constitution of the Republic of South Africa clearly states that every individual has the right to adequate housing.[29]; however, it is evident that millions of South Africans still reside in inadequate informal settlements and the country is experiencing a housing delivery backlog of 2.4 million houses. [28]

The United Nations (UN) has estimated that worldwide one billion people live in “slums” and this number is projected to double in 15 years’ time.[27] Slums are often characterized by shacks clustered in one area. These are impoverished households made from metal, plastic and wood containing minimal access to basic infrastructure and services. [27]

Informal settlements however are not always located in collective regions and the term slums cannot always be applied, it is for this reason that a sub-set of informal housing is referred to as backyard dwellings.[27] 'Backyard dwelling' is a special term used in South Africa, this refers to shacks built onto an existing dwelling by inhabitants in the yards of other people. [27] Approximately 5.7% of all South African households reside in backyard shacks.[24] The South African Institute of Race Relations reported that there is a rapid increase in the number of people residing in backyard dwellings than the number of people living in informal settlements.[24] Shacks lack sanitation, water, electricity and proper waste disposal amenities.[30] The number of shacks that occupy a landlord’s plot depends entirely on the landlord and theses shacks share water, electricity, sanitation and refuse collection with the landlord while renting the designated space.[27] There are inadequate waste disposal facilities for backyard shack dwellers and as a result the direct clearance of raw sewage from these settlements into the environment poses a huge risk for the spread of diseases and environmental degradation.[30]

Numerous households stated that they disposed of human excreta in hazardous ways that promoted the spread of pathogens in the environment.[31] These inhabitants often dispose of their polluted waste in the nearby surroundings thereby contributing to environmental pollution.[31] Contact with waste was found to be a vital factor linked with diarrhea amongst children residing in an informal community of Salvador Brazil.[31] Inadequate waste disposal serves as breeding grounds for disease-carrying insects such as flies, cockroaches and rodents.[31] Informal settlements are found in many urban cities and are distinguished by the presence of poor housing, poor infrastructure, poverty, various health and social challenges.[32]

In South Africa, the Western Cape has a fairly well urbanized southern region. Cape Town is the main urban city.[32] The rapid population growth due to migration has excessively affected the informal settlements and has hindered the government in basic service delivery and housing delivery.[32] The shortage of housing and employment have led to harsh living conditions, often in poorly constructed dwellings.[24] Such houses are usually located in potentially contaminated sites close to factories or major transport routes or in sites prone to flooding, and with poor service delivery such as adequate water and sanitation, waste collection and sewage treatment.[24] People with a low income tend to have difficulty maintaining their dwellings and over time the inadequate maintenance leads to structural deterioration. This in turn can trigger stressors that can put pressure on the human immune system. One such example is the high prevalence of diarrheal cases linked with poor housing conditions.[24]

Inadequate housing has public health issues and it is with the urban poor communities where these issues are dominantly visible.[25] Features of inadequate housing include; “inadequate insulation leading to dampness and mould, lack of heating and ventilation, lack of safe drinking water, ineffective waste disposal, inadequate facilities for food preparation, households pests such as ants, cockroaches and rats”.[33] Unsanitary environments can lead to skin infections, repeated diarrhoea, worm infestation, and a weakened immune system.[34] It is therefore important to provide people with proper sanitation infrastructures to alleviate these diseases and decrease mortality rates. Proper sanitation facility serves to prevent diseases by removing the human waste from the human settlements.[34]

An adequate sanitation facility is one that can hygienically disengage human excreta from human contact.[35] Suitable sanitation types include a flush/ pour-flush toilet that is connected to a piped sewer system or septic tank, a pit latrine, a ventilated improved pit latrine, a pit latrine

with a slab, or a composting toilet.[35] Vaccines have been developed for the prevention of some of these communicable diseases however water, sanitation and hygiene remain the pivotal aspect for the prevention of communicable diseases.[36]

1.4 Access to water and sanitation

The importance of access to water, sanitation and hygiene is essential for health.[37] In 2015 71% of the world's population had access to adequate drinking-water source, that is a tap located in their home contamination free, however 844 million people still had no access to basic drinking water service.[38] Only 39% of the global population had adequate sanitation facilities and a recorded 2.3 billion people of the world's population still had no access to basic sanitation facilities.[38] A total of 600 million people used shared sanitation facilities and 892 million people globally practiced open defecation.[38] Proper sanitation does not only improve the health and well-being of the community, but also plays an important role in advancing the economic status of the poor.[34] Ndinda[34] stressed that with proper sanitation facilities the people in urban low-income communities are less prone to sanitation-related diseases, for example diarrhoea. Widespread and recurring diarrhoea is costly to treat and according to the WHO[39] May 2017 report, accounts for approximately 525 000 worldwide fatalities among children under the age of five.

Despite the reasonable progress made by South Africa in improving access to adequate sanitation from 51% in 1990 to 66% in 2015, still approximately 1 in 5 children of the poorest households only have access to inadequate drinking water.[40] More than 1 in 5 schools lacks satisfactory water supply and 29% of the schools makes use of inadequate pit latrines or lack toilet facilities.[40] The continual world urbanization has resulted in cities having to bear the burden of providing water and proper sanitation to a vast number of people.[41]

Access to adequate drinking water and sanitation is a basic human need, but in spite of the significant gains to improved sanitation facilities, the world failed the millennium development goal (MDG) target for sanitation for approximately 700 million people.[42] It is a said that "Every two minutes, a child dies from a disease linked to unsafe water and sanitation".[43]

In low-and middle-income countries the number of people that die due to inadequate water, sanitation and hygiene is approximately 842 000 people yearly.[42] This accounts for 58% of

total diarrhoeal fatalities.[42] Adequate water and sanitation facilities are crucial in addressing the continual dangers of infectious diseases. [44]

1.5 Waste - a hygiene issue

"Wastes are inevitable part of human activity". [45] With our population growth rate increasing annually, it has been inevitable that small villages grew into towns, and the towns became cities. With all these changes taking place, the amount of waste generated annually has increased proportionally.[45] With such large volumes of waste being generated it is predicted that waste threatens humanity's health and natural resources.[46] Inadequate waste management leads to the pollution of water, soil and the atmosphere, all of which have direct implication to the health of the public.[47] Waste has such diverse repercussions for the population it is therefore important to understand what is meant by the term waste.

Waste consists of a vast number of materials, and it is often noted that one individual's waste may be another individual's livelihood.[48] There are various definitions for waste and experts do not often agree on them nor do ordinary people. The National Environmental Management Waste Act (NEMWA) of South Africa defines waste "as any substance, if the substance can be reduced, re-used, recycled and recovered". Another source defines waste with three definitions, based on the four classes of waste identified in Table 1.1. Definition 1 states that "waste is a man-made thing that has no purpose or is not able to perform with respect to its purpose".[49] Definition 2 states that "the ownership over a thing can be defined as a right and responsibility to act upon the thing that is to manipulate the properties of the thing".[49] Lastly definition 3 refers to "waste as a man-made thing which in a given time and place in its actual structure and state is not useful to its owner, or an output that does not have any owner".[49]

Table 1.1: Classes of waste [50]

Class	Description
Class 1	Non-wanted things created not intended, or not avoided, with no Purpose
Class 2	Things that were given a finite Purpose thus destined to become useless after fulfilling it
Class 3	Things with well-defined Purpose, but their Performance ceased being acceptable
Class 4	Things with well-defined Purpose, and acceptable Performance, but their users failed to use them for the intended Purpose

Most classifications describe waste either by their state (solid, liquid, gaseous) or by their origin (processing household, packaging, or cleaning waste).[49] Wastes are often grouped in various categories, for example biodegradable (decomposable wastes) and the non-biodegradable (non-decomposable wastes).[51] Depending on their source of origin, wastes are further grouped as either municipal (residential/domestic and commercial), industrial, and construction and demolition wastes.[5]. For the purposes of delivering municipal waste services, waste streams (as they are called) are divided into solid waste, sewage, grey water (wastewater excluding sewage) and stormwater.

1.5.1 Municipal Solid Waste (MSW)

In general, solid waste is any substance that is unwanted in the home, although the substance can be reduced, re-used, recycled, or recovered. Improper solid waste disposal can lead to land pollution, water pollution and air pollution.[52] Inadequate waste management is one of the main causes of environmental pollution and degradation in many urban cities and towns, particularly in developing countries.[53] The World Bank states that the current Municipal Solid Waste (MSW) generation levels are approximately 1.3 billion tonnes per year globally and is anticipated to increase to approximately 2.2 billion tonnes per year by 2025. In South Africa, the Western Cape documented the second highest municipal waste after Gauteng with a production of 675 kg/capital/annum.[54] The Western Cape produces 3.8 million tonnes of waste per annum of which 70% (2.6 million tonnes) is produced by the City of Cape Town.[55]

MSW contains many types of waste, for example recyclable waste, which normally includes paper, plastics, metals. Toxic wastes, which include paints, pesticides, used batteries, medicines. Compostable organic wastes, which comprises of fruit and vegetable peels and food waste. Soiled waste, which are things such as blood-stained cotton, sanitary napkins, and disposable syringes. These waste types are all domestic components and as such the terms MSW and Domestic Waste are often used interchangeably [56] [45] but that can cause confusion in the South African context. Domestic waste is a generic term encompassing all waste generated in and around the household, including greywater. Solid waste is the solid component of that waste, that in serviced areas is deposited in a waste bin that is supposed to be emptied regularly by the municipal waste management services.

South Africa is a developing country and cannot at present deliver an optimal level of services to all communities. In low income communities and informal settlements solid waste is supposed to be deposited in large containers placed in strategic sites for use by the households serviced in that area. These containers are called skips and are hooked up to a truck at intervals and taken to the municipal dump site. They are somewhat similar to what are called dumpsters in the USA. Unfortunately, in many places the volume of solid waste generated in the area serviced by the skip overwhelms the capacity most times, since the number of skips are inadequate and collection rate is slow. Thus, the area around the skip becomes littered with solid waste and decaying food. In informal settlements with no formal toilet facilities, the skip also receives a lot of human sewage. Thus, the solid waste in those areas is suffused with sewage and other organisms of decay. It is not uncommon to find dead animals such as cats and dogs, offal from informal slaughtering and old car oil amongst others in these skips. Thus, the contents of most of these skips are hazardous indeed.

Given the limitations of the solid waste services in informal and low-income areas, the inhabitants of those areas unfortunately grow up being used to dirty environments and they often do not learn to practise neatness and responsible waste disposal in public places. So, they also contribute to the general image of dirty environments in their communities.

Keeping in mind the limitations of the solid waste system in operation in places like Mbekweni, it is not surprising that solid waste is found at a high volumes on the streets and often might appear that the sanitation services do not allocate much attention on the matters regarding the hygiene of the communities.[57] It is not uncommon to see bags of waste on the streets and water

channels in low income communities. Often this practice is done with the hope that the local municipality will come and collect the waste.[57] The disadvantage to this practice however is that the bags of waste are left there for weeks on end, before being collected.[57]. This is similarly found in the Mbekweni community. The abandoned waste generates a bad odour, attracts disease-carrying rodents and flies and serves as a breeding ground for microorganisms that are dispersed into the environment.[57] Decaying or contaminated solid waste has serious health implications for both the workers and the people who live around any waste disposal site, even the informal ones.[58] These informal disposal sites often harbour insects, rodents and other pests that can serves as vectors for diseases such as dysentery, typhoid fever, diarrhoea, and other diseases.[58]

The waste generated in the households is mostly food-based and it is for this reason that organisms, insects and rodents are drawn to it.[58] These are all pests that can pass diseases to humans and when near the residences, the rate at which the diseases spread is elevated.[58] Inhabitants often do not connect the presence of flies, cockroaches and rodents to the waste that they leave for long times inside their own homes, as well as the waste strewn around the home, The organisms associated with the refuse that is located close to the residential homes does not only causes diseases but can also lead to further contamination of the wider environment.[58]

The environment in low income areas is of a poor condition, while the buildings in these townships are constructed of low-grade building materials and scrap materials which are subjected to deterioration. Such buildings are in constant need of renovation and maintenance, further impoverishing the inhabitants.[58] Other negative environmental effects caused by improper MSW disposal includes pollution of the surface and underground waters, high fire risk due to inappropriate use of flammable construction materials and the presence of open fires for cooking as well as other environmental pressures such as flooding due to solid waste blocking storm water channels.[51]

Municipal solid waste when handled properly yields positive impacts by lowering the risk of sanitation diseases in these communities. With global warming becoming more apparent, MSW also contain a substantial portion of potentially recyclable material which possess a substantial amount of energy that can bring environmental as well as economic benefits when exploited efficiently.[59] It has been evident that the health implications of inadequately handled

waste are plentiful and the severity of the health impact depended on nature of the waste, the exposure and duration rate and whether there was any intervention protocols set in place.[60]

1.5.2 Industrial and Hazardous waste

Hazardous wastes can be distinguished by their properties and these properties usually entails corrosivity, reactivity, toxicity, ignitability and persistence[61]. The properties of hazardous waste and the way in which individuals can come into contact with it (ingestion, inhalation or contact) can pose serious health and environmental issues.[61] Increase in industries means an increase in the industrial waste generation and it is the industry responsibility to collect, store, transport and dispose of the industrial waste.[61] Inadequate industrial waste disposal can result in the contamination of ground water.[61] The tobacco industry is one of the strongest industries globally and it produces non-biodegradable waste. Non-biodegradable waste cannot be broken down into its simplest form by microorganisms, air, moisture or soil in a decent time frame.[61] Most of the cigarettes are made up of filters and these filters consist of cellulose acetate which is a plastic product.[62] Cellulose acetate is photodegradable but non-biodegradable, thus even though the ultraviolet rays produced by the sun will eventually break down the filters into, their ideal environmental conditions, the material itself never decomposes, it usually becomes diluted in water or the soil, thus creating toxic waste disposal problems.[62] Since the discarded cigarette butts are of a non-biodegradable nature, they are often present on the streets where they eventually find their way to the drains, to the rivers and lastly to the oceans and its beaches where they pose as threats for marine life.[62]

Another example is the health sector industry, although its main function is to care for the people, repair their health and save lives, in the process a lot of wastes and by-products are generated and when not properly handled can be harmful to the public.[63] Health-care waste (HCW) often carries toxic microorganisms that have the potential to infect patients, health care workers and the overall public.[63] A communicable threat to consider is the spread of drug-resistant microorganisms from the health services into the environment.[63] Health care waste contains three types of waste namely general waste, hazardous waste and highly hazardous waste. [64]

Table 1.2: Types of healthcare waste (HCW) [64]

Type	Definition
General (HCW)	Closely resembles the MSW, it is mostly harmless and requires no special disposal care (75-90% of health care waste lies this category).
Hazardous	Waste that contains infectious waste, except for sharps and waste produced by patients with highly contagious diseases. This waste also consists of e.g. chemicals and pharmaceuticals as well as the non-recyclable pressured containers.
Highly hazardous	Contains waste from highly infectious patients (stools and bodily fluids from infected persons), non-sharp waste, and contain "large quantities of expired or unwanted pharmaceuticals as well as hazardous chemicals that could be radioactive or genotoxic wastes".

Table 1.2 highlights the various waste types produced by health care facilities and it is therefore important that waste generated by health care facilities be properly disposed in order to prevent the spread of communicable diseases and ensure sustainability of the whole ecosystem.[64] In Mbekweni community there are two health care facilities, namely Mbekweni clinic and Phola Park clinic. In Mbekweni clinic, the health care waste is stored in boxes and sharps containers. The sharps containers are usually reserved for sharp needles and kept in a room with a monitored temperature and on Thursdays a private service provider called Averda Company collects the waste.

1.5.3 Storm water, Grey water, and Sewage

When dealing with urban drainage systems, it is often seen that informal settlements faces many challenges.[65] During the winter season storm water poses a huge challenge for shack dwellers. Such challenges include the leakage of roofs and walls, the damp floors created by the water entering the house and the community being affected by the water puddles that causes difficulty for walking and transport accessibility.[65] Some dwellers suffer from exposure of the run-off water from the roads that enters their home.[65] Rain is also known to wash off toxic litter, food waste, animal faeces and human wastes from the leaking communal toilets, overflowing latrines and open defecation across the land into the homes.[65]

Grey water is another supply of urban drainage water that is as created by daily domestic activities (dishwashing, bathing and cooking).[65] Informal settlements dwellers often get their water in buckets from communal taps, which are often standpipes with or without a basic drainage elements.[65] It is often noted that when residents do their laundry there, the grey water near taps or homes contains contaminants of foods and faecal substance that had spilled over to the ground, resulting in water ponds.[65]

Grey water disposal is the duty of household and often noted that many households do not have bathrooms, and those with bathrooms lack soakaway pits thus resulting in uncontrolled release of untreated grey water.[66] Irrespective of the initial contamination level of grey water, it is regarded to develop high microorganism loads within 24 to 48 hours after its creation.[65] This poses a huge health concern to young children who are subjected to grey water channels and ponds as they contain pathogenic microorganisms.[65]

Sewage consists of water carrying all substances entering the waste system, but combinations of excretions (faeces and urine), toilet paper, personal care products and food wastes generated by people are the most common, as well as household chemicals such as cleaning products.[67] Sewage liquid contains urine and wastewater which originates from the toilet, the kitchen, bathroom and laundry.[67] Pathogens can spread from sewage when there is inadequate sewage disposal or a lack of good toilet hygiene practices.[67] Improper sewage disposal can lead to human illnesses such as infections (for example enteric illnesses, non-gastrointestinal infections and respiratory diseases).[68]

The vast majority of toilets in informal settlements communal and are unsanitary and malfunctioning, often overused and at an inconvenient distance, especially for women and children.[65] Often residents in these communities create their own 'toilets' that are shared by numerous households or used by a single family. These types of toilets are usually a chamber pot inside the dwelling or an outside latrine.[65] Whichever form the residents used, these toilets usually lack the proper drainage systems, which means that the waste is often most left in one place for a long period of time and are susceptible to flooding.[65]

The pathogens causing diseases can spread directly by people encountering sewage or toilet waste by either walking through the sewage that is leaking onto the ground due to broken or

blocked sewage pipes,[67] or indirectly by people encountering flies, cockroaches, cats and dogs which carry the pathogens on their bodies, or by consuming sewage contaminated water.[67] There are various factors that facilitates the transmission of pathogens from sewage, such as not washing your hands after toilet use, sewage collecting in water puddles, clogged flooding toilets, filter drains from septic tanks located close to drinking water sources.[67]

Improper solid waste management poses serious health effects as most people living in urban poor communities make use of different water sources such as rivers and dams, these water streams are easily contaminated when there is poor waste disposal practices and poor sanitation practices and contribute in the wide spread of waterborne diseases.[69] There is often poor provision for the safe disposal of domestic animal waste. Some zoonotic diseases can increase in situations where animals are not kept under good conditions or live in intimate contact with humans.

1.5.4 Recycle, re-use and recover

Municipal solid waste is the one of the main environmental issues in urban areas.[70] Improper management of municipal solid waste poses different types of environmental pollution (air, water and soil), thereby affecting public health by acting as breeding grounds for many disease-carrying vectors (such as flies, rats).[70] Understanding the composition and characterization of municipal solid waste is crucial in ensuring that the appropriate waste disposal and management strategy, as well as recovery of materials, are met.[70]

In South Africa, it is the municipalities' responsibility to ensure that services are provided to communities. Further, these services help ensure that communities exist in an environment that is not harmful to their health and well-being.[71] This requirement can be met by ensuring that the community is not degraded or contaminated.[71] In order to ensure that the community is kept clean, it is important to understand the different types of waste main streams generated by the community and impact that these waste streams can have on the quality of water and the surrounding environment.[72] The importance in the way the municipality manages waste is reflected on their resident's health and quality of life.[71] The waste generated by the population ultimately returns to the natural environment (water, air or the land), and, when inadequately handled, can result in the pollution of the environment.[71]

According to the South African Department of Environmental Affairs and Tourism (DEAT),[71] the shift has changed from focusing on the storage, collection and disposal of waste to placing more emphasis on waste prevention systems.[71] The population is encouraged to use every alternative method possible to minimise the production of waste. The waste management hierarchy as per the National Waste Management Strategy (NWMS) is depicted in Figure 1.1:[54]

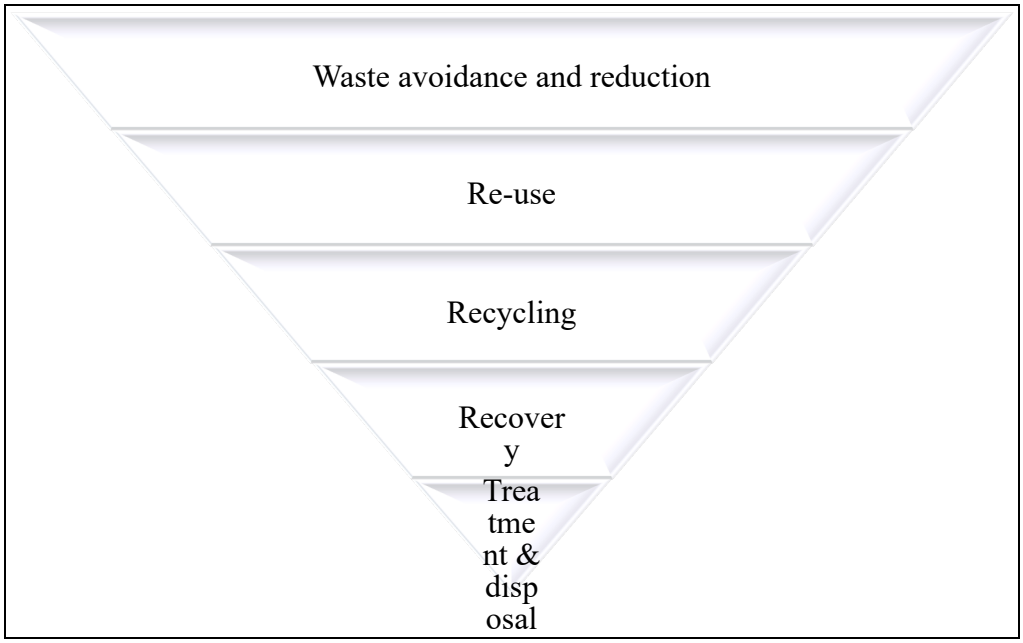

Figure 1.1: Waste management hierarchy as per the NWMS [54]

Highlighted in Figure 1.1 is the order of preference when dealing with waste and all integrated waste management plans are required to adhere to this waste hierarchy.[73] The central component of this waste hierarchy is recycling which has been observed to be a core source of employment creation in waste management.[73] South Africa has practiced waste recycling for many years; however most municipal solid waste is still not separated at source and this make the recycling process ineffective.[73] When recycling takes place far from communities, it becomes a cost issue in terms of transporting the waste.[73]

Recycling is one of the various ways used by the municipality to minimize waste. It is a process that recovers disposed products or materials and transform them into new or different products.[71] The scope in which this term is used is broad enough to describe the full cycle from the collection to production point.[71] Recycling can be an effective waste management tool with various benefits; saving natural reserves and energy, lower environmental pollution, less demand for landfill space and generation of job opportunities.[74] This process entails that the recyclable material gets separated from the waste stream. The success of recycling not only

rests of the separation of the items, but also, most importantly, on the proper and accessible industrial technology to do the reprocessing into usable materials. Such recycling facilities for all the different kinds of recycling (plastics of many kinds, metal, glass) are still in very short supply in South Africa.

"Informal sector recycling is defined as individuals or companies that extract recyclable material from mixed municipal solid waste".[75] Informal waste recycling is often carried out by individuals who live in a poverty state and use this method as their source of income.[75] This process is quite popular among the Mbekweni residents, where individuals collect material and sell it to a recycling company nearby. It must be noted that such informal recycling poses risks for these persons scratching through the waste of others in order to retrieve useful items. They are exposed to a large number of pathogens in the process and can pass diseases on to other persons that they come into contact with.

Other waste minimisation methods involve re-use and repair, which simply means to use an item again for the same function or repair, to recover the item that was no longer in use due to its malfunction.[71]

1.6 Communicable diseases associated with poor living conditions

The UN-Habitat predicts that approximately 40% of urban dwellers resides in slum and that these slums consist of poor sanitary conditions.[76] Many urban dwellers on the African continent reside in rapidly growing informal settlements that experience a shortfall in sanitation services.[76] These insanitary conditions for poor urban dwellers are further worsened by the increased density of the living area, insufficient septage as well as poor management of solid waste and inadequate drainage.[76] In many developing countries, there are major inequalities of access to sanitation between the poor and the affluent portions of society.[76]

South Africa's water and sanitation backlog is partly an inheritance from the Apartheid era. After major changes in the political system, South Africa inaugurated the notion of water and sanitation as a human dignity to which every South African has an equal right.[77] During 2011 renewed attention was paid to the dire sanitary conditions of informal settlements in the Cape Town area of the Western Cape.[78] Without proper sanitation, diseases such as diarrhea and

worm infections will continue to increase and influence our quality of education, productivity and quality of life for all urban inhabitants.[76]

Infectious diseases are of major concern for public health and remain the leading causes of mortality and morbidity in poor communities.[2] Population density is problematic for urban sanitation for two main reasons, firstly individuals are exposed to pollution that they did not create, in urban areas inadequate sanitation is strongly linked to stunting and this effect is impartial of income, thus all urban dwellers are at risk from inadequate sanitation.[76] Secondly the smaller space inhabited by poor households leave little room for concealing and safe abandonment of a full latrine pit and a construction of a new one in a different place.[76] Often however, low-income communities have sanitation facilities but there are various factors that contribute to their poor conditions.[76] These are poorly constructed or maintained on-site facilities, inadequate water supply, toilets discharging into poorly functioning open drains blocked with uncollected solid waste, malfunctioning and abandoned communal toilet facilities and lastly inadequate services for managing the faecal sludge from on-site facilities.[76] Many houses are built directly over open drains, thereby worsening drainage and flooding problems.[76] Water-borne diseases results from the usage of contaminated water for various human activities.[79] The most common bacterial agents responsible for waterborne outbreaks are; *Salmonella, Campylobacter and Escherichia coli (E.coli).*[80] Diarrhoea, as already mentioned, as one of the leading cause of fatality among young children[81] and inadequate water quality is the major contributing factor for diarrheal disease.[82]

1.6.1 Diarrhoeal Disease

Diarrhoea is an indicator of gastrointestinal infection which is usually caused by various bacterial, viral and parasitic organisms.[39] Apart from inadequate clean water, the infection also spreads by means of contaminated food or person to person contact due to poor hygiene.[83] An estimated 1.6 million children in developing countries die from diarrheal diseases yearly. [84]

Enteric pathogens have the potential to trigger approximately 1.7 billion diarrhoea cases per year globally in children younger than 5 years of age and is responsible for roughly 10% - 15% of fatalities in this age category.[35] Children from developing countries are subjected to enteric pathogens at an early age through contaminated food, water, human hands, soil and fomites,

and this frequent exposure leads to high gastrointestinal infections, undernourishment and growth stunting in young children.[35]

Faecal sludge and fluid wastes from on-site systems are poorly managed in low income communities in most parts of the world. The large volumes of faecal waste that is collected is often buried in backyards or deposited on waste land or in natural or manmade drainage channels.[76] Diarrheal disease shows an association with the low socio-economic status and it is in the underprivileged communities of South Africa where severe cases are mostly found.[85] South African children living in poverty are at a higher risk of dying from diarrheal disease than those living in privileged communities.[85] Improved sanitation encompasses water-based toilets that can flush into sewers, a fully functional septic systems, and ventilated improved latrines. Strong reduction in diarrheal morbidity has been associated with improved sanitation conditions.[86]

Diarrhoeal disease was reported to be responsible for 24% of fatalities in children between ages 1-5 years.[84] Faecal contamination play a role in the continuation of diarrheagenic pathogens in the environment and these diarrhoeagenic pathogens have the potential to affect both food crops and water sources.[87] Cattle farming and sewage spills often cause the spread of diarrheagenic pathogens into the environment and that can lead to diarrhoeal disease.[87] Human body waste has been shown to contain more than 50 known bacterial, viral, protozoan and helminthic organisms.[36] There are numerous transmission routes for excreta-related illness,[36] and transmission can be direct via contaminated hands or indirect transmission through the ingestion of water, soil, food or through vectors such as flies.[36]

1.6.2 Other diseases often associated with poor living conditions

Water-borne diseases are not the only ones that affect the public health; air-borne diseases also play a significant role in the health of the population. Air-borne diseases originates when a microbe from an infectious point is transmitted over a certain distance via air particles and come into contact with a person who have not been exposed to the infectious microbe.[88] Tuberculosis (TB) is one such example, this disease is caused by *Mycobacterium tuberculosis* (*MTB*), a pathogen that was first identified by Robert Koch to be responsible for this disease[89]

and it can spread from one person to the next person through air particles and is ranked among the top 10 leading causes of deaths globally.[90] [91]

The African Continent is responsible for over a third of the global tuberculosis disease cases and tuberculosis-associated fatalities.[92] South Africa is ranked the third highest tuberculosis incidence country in the world accounting for 948 cases per 100,000 people yearly.[92] The tuberculosis epidemic is fuelled by the human immunodeficiency virus (HIV) infection and its link to active TB disease and growing resistance of *Mycobacterium tuberculosis* strains against anti-tuberculosis drugs.[93] TB is spread from one individual to the next individual via air particles.[94] It has been said that the range of conditions under which many lower income communities live have enhanced the spread of HIV and TB, and arise from the apartheid era.[95] South Africa contains the biggest population of individuals living with HIV (approximately 6 million diagnosed cases in the year of 2010).[96] Prevention measures can be applied to reduce the spread of these infections and to promote longer life quality for individuals living with these diseases.[96] Widespread voluntary counselling and testing of individuals aged 15 years and more and the speedy provision of ART on HIV infected individuals has shown to be effective in minimising the spread of these diseases.[96] Antiretroviral therapy (ART) has altered the lives of HIV-infected individuals in South Africa by increasing their survival changes.[97]

Pneumonia or lower respiratory tract infection (LRTI) is another air-borne disease example that is caused by various microorganisms.[98] Pneumonia is a major cause of mortality among children contributing approximately 17% towards the mortality rate.[99] [100] *Streptococcus pneumoniae* is the main organism that causes pneumonia in children.[98] It is a respiratory infection that affects the lungs and is acquired by coming in contact with an environment that contains the pathogenic microorganisms or is acquired from person to person contact by means of hand contact or the inhalation of air particles in the atmosphere from the coughing or sneezing of an infected individual.[101] Pneumonia disease is excessively high in African children, with 36 million pneumonia cases and 600 000 pneumonia-associated deaths reported annually.[99]

In South Africa, individuals aged 25-44 years old who have been diagnosed with HIV are the second highest group of people who are at risk at acquiring pneumococcal disease.[102] HIV-infected children are more prone to acute lower respiratory tract infection (LRTI), to be hospitalised, and to die in hospital when compared with HIV-uninfected children.[103]

Respiratory infection is highest in low and middle income countries.[100] South Africa however became the first African country in April 2009 to initiate the pneumococcal polysaccharide-protein conjugate vaccine (PVC) into its immunisation program.[104] Maternal education regarding the prevention and early response to LRTI in children was also said to reduce the incidence of pneumonia, thereby highlighting the importance of education for the health of the public.[99]

Although there are limited studies that reveal the linkages between waste disposal routes and health issues of low-income communities, it is clear that improper waste disposal is correlated with various infectious diseases. Various studies have highlighted the linkages of poverty and health; however, there are limited studies that show linkages of urban poor communities and their waste management knowledge and the various health issues they encounter. The population is increasing at a rapid rate and this means that waste generation will accumulate as estimated by the World Bank Organization. It is important for the public to know the possible health outcomes associated with improper waste management and the possible methods residents of low-income communities can employ to sustain a healthy community.

1.7 Background and history of Mbekweni

The history and background of almost all townships in South Africa that are connected to towns are poorly documented and much of this information is being lost since those involved in the early development of these communities are dying. The following is an attempt to record the background that is relevant to the topic of this thesis. This was collated by the candidate from multiple oral sources in the community and serves as a record of the information since this area had not been the subject of any formally published research that could be traced.

Drakenstein Municipality is located in the Cape Winelands District of the Western Cape and viewed as the most highly populated municipality in the Cape Winelands region.[105] Paarl and Wellington are the main urban centres of the Municipality[105] while Mbekweni is a township that is situated in the Bergriver valley and whose present boundaries stray into the old municipal boundaries of Wellington and Paarl.[106] Most of the population live in what were the old municipal areas of Paarl (44.6%) and Wellington (22.1%). Mbekweni comprises 12.3% of the 251 262 inhabitants living in the present Drakenstein Municipality and 14.7% living in the Drakenstein Non-Urban (NU) areas.[105] Mbekweni is a community comprising mixed dwellings

(informal houses, and formal low-cost houses). A sizeable number of Mbekweni residents live in shacks that are no larger than 10 square meters.[105]

Figure 1.2: Cape Winelands District map showing the location of Mbekweni[107].

The word Mbekweni, when translated into English means "a place of respect", which was what the place signified in the past.[108] The history of the community dates to 1951. Due to the influx of black population to the area, and illegal squatting, Act No 52 of 1951 resulted in the removal of Hugenote, Suider Paarl, Klein Drakenstein and Dal Josaphat squatter camps and many of the unemployed men, women and their children were sent back to the Eastern Cape (previously known as Transkei).[106] After the eradication of squatter camps, the Paarl municipality was to provide housing for the remaining squatter population, this lead to the establishment of two locations.[106]

Mbekweni was one of those locations and the community was built to house mostly single men in hostels, only 30 units/houses were allocated for families.[106] The four blocks were named A,B,C,D and housed 2000 single male workers.[106] The second location was named Langabuya and was a back-up camp.[106] Langabuya was shut down in the late 1960's and all the black residents moved into Mbekweni.[106] Later many of the single men units were converted into family units, however there were still single men quarters owned by private companies for their

workers. Despite the hostels being designated for single men, they still housed one or more families in each room.[106]

During the period of 1950-1984, both Paarl Municipality and Administration Board built a total of 837 family houses.[106] The township was managed by an Administration Board with a local residents committee up until the 1983.[106] The Black Local Authorities Act of 1982 (No.102 of 1982) permitted structures to be set up in a way that would allow black areas own local authorities.[106] The Black Communities Development Act (Act 4 of 1984) allowed for the Administration Boards to be Development Boards and were there to assist the Municipal Authorities in becoming fully developed local Authorities.[106] In 1986 new houses that were built by private companies were sold between R38 000 and R65 000 and were mostly afforded by governmental workers.[106]

An area called Silverton was made up of 200 galvanised steel, one-roomed structures and the living conditions were extremely poor.[106] The Silverton area had bucket latrines that were cleared twice a week and a single tap that was used by 30 houses.[106] Many of the workers worked at the Berg River Textiles factory, Langeberg Food factory and the surrounding wineries provided various job opportunities for these male migrants. The Berg River Textile factory in Paarl is known to produce high quality, woven cotton and polycotton fabrics, in dye and printed forms.[109] Langeberg canning factory was established in 1940 and in 2005 Langeberg Foods International merged with a privately owned Asthon canning company to form Langeberg & Ashton Foods (PTY) LTD that is still successfully operating to date.[110]

Figure 1.3: Mbekweni in the year 1955 (Spogter N. Drakenstein Municipality. Personal communication. NopinkyS@drakenstein.gov.za. 05-10-2017)

There is little literature on Mbekweni, which is why some of the history and evolution of the place rests on oral accounts of a local resident who has lived there long enough to experience the changes of the community. In search for a better life, like the many dwellers in this community, the 52-year-old man moved to Mbekweni when he was 15 years old. He notes, "*The town was small in geographical size and it consisted of block houses where the single men migrant workers took refuge*". The block houses were and still are named in alphabetical order namely block A, B, C and D plus another set of block houses named White City, were assigned exclusively to single men workers. The location was also in alphabetic order with MQ block being the foundation block of Mbekweni community and the other blocks namely E, F, G, H, M, L, K, R, O, P, Q an S. All these block houses consisted of family units and were made of brick and mortar with indoor plumbing, electricity, and toilet facilities.

The shops and basic businesses were in Hugenote town, an area that is approximately 7 km from Mbekweni. To obtain food and other essential goods, the community needed to go to Hugenote Town. During those days, Mbekweni only had six taxi owners but at that time the taxis were in the form of private cars because they did not have buses or minibuses as seen much more frequently today. There were, however, city buses that transported people from Mbekweni to Hugenote area, where all the local businesses were situated. Today, the taxi industry has evolved, more taxis transport people from Mbekweni to town and back. Many of the taxi owners also have contracts with families that send their children to study in town to transport their children from Mbekweni to their school and back home safely. The taxi industry is therefore one of the main modes of income and transport for people in Mbekweni.

"People enjoyed life back then, they had a peaceful community where one could walk to any place at any time of the night or early hours of the morning without being harassed or robbed" says a local resident of the Mbekweni community….. "Mbekweni did not have many shacks back in the olden days; it only contained a few back-yard dwellers. With the ANC coming into power in the year 1994, the Reconstruction and Development Programme (RDP) aimed to provide houses to people with low incomes. Areas namely Thembani square, Phola Park, Chris Hani Square, Project One and Project Two all form part of the expansion of Mbekweni. Many early developmental projects evolved such as youth centres, a library, shopping centre, doctors consulting rooms, clinics, municipal offices, fire brigade as well as its own police station. This made life easier for the inhabitants because it meant that they no longer had to travel to Hugenote town every time they needed basic services.

Mbekweni currently has three primary schools and two secondary schools. The primary schools are Mbekweni Primary School, Imboniselo Primary School and Langabuya Primary School. Mbekweni Primary School registered 1302 leaners for 2017, Imboniselo Primary School enrolled 1427 leaners for 2017 and Langabuya Primary School recorded 1441 learners for the year 2017. Ihlumelo Secondary School recorded 1241 leaners for 2017 and Desmond Mpilo Tutu Secondary School recorded 1347 learners for 2017. Mbekweni has also over the years increased in population sizes from approximately 20000 people[106] to 30875 people according to the last available (2011) census,[111] the open spaces in the community were later used to build houses to cater for families. Mbekweni has then evolved and grown even bigger, with the addition of more areas such as Dube residential zone, Langabuya and the youngest area called Dromedaris.

Figure 1.4: Mbekweni in the year 2000 (Spogter N. Drakenstein Municipality. Personal communication. NopinkyS@drakenstein.gov.za. 05-10-2017)

During the earlier years, the highest causes of mortality in the Mbekweni population was "respiratory disease, heart disease, prematurity and congenital defects, malignant tumours, disease of blood vessels, Tuberculosis, manslaughter, diseases of intestines, road accidents and measles".[106] Cases of TB in the Cape Wineland District was reported to have affected approximately 7325 patients during 2013-2014 and in 2014-2015 the number of TB patients was approximately 7545 patients.[112] In their study, Grundlingh and McDougall[108] reported that fifteen percent of the Mbekweni residents lived with HIV/AIDS and that there is a high incident rate of epilepsy.[108] Mbekweni community also suffers from high teenage pregnancy, abuse and children who have been abandoned by their parents as well as alcohol and drug addiction.[108] The drug-related crimes in Mbekweni increase yearly as revealed by Crime Statistic SA - from 70 cases in 2008 to 107 cases in 2010.[113] This problem in ongoing as Crime Stats SA reveals a further increase in drug-related crime cases from 218 cases in 2016 to 240 cases in 2017.[114]

There are various factors that are important in ensuring good health and quality of life of any community.[61] These diverse factors ensure that communicable diseases are kept at low frequencies in the community. One such factor is the lifestyle aspect of the community and is highly dependent on the local authority providing its residents with adequate water, sanitation facilities and proper solid waste removal so that they are not exposed to disease causing microorganisms.[115]

Figure 1.5: Mbekweni in the year 2016 (Spogter N. Drakenstein Municipality. Personal communication. NopinkyS@drakenstein.gov.za. 05-10-2017)

1.8 Importance of the study

Household sanitation and hygiene practices are crucial elements for inhabitants in the home to stay healthy.[116] In low-income homes however, especially those homes where the sanitation infrastructure is insufficient or absent, safe hygiene, sanitation and waste disposal becomes problematic and difficult to maintain.[117] Many of the informal settlements lack proper drainage system to properly dispose of grey water waste, storm water waste and sewage water waste.[118]

The site chosen for the present study - Mbekweni - falls under the Drakenstein Municipality, which is one of the largest municipalities in the Cape Winelands District. The community comprises approximately 11% of the population in the jurisdiction area of the Drakenstein Local Municipality's (DLM).[119] Mbekweni consists of mixed dwellings, informal houses made of poor materials and often classified as shacks and RDP houses.

In Mbekweni community there are numerous instances of dirty water running down the streets, blocked drains, water puddles near informal houses and informal waste dumps. Inadequate sanitation and the lack of access to safe drinking water remain a big concern for people living in low income communities.[69] Unhygienic practices exposes people living in these communities to water and sanitation related diseases.[120] Residents experiencing these situations have lived in a polluted environment that has flies, mosquitoes, blocked drains, polluted air from the burning of refuse.[69]

Understanding both the hygiene and waste management practices of a community allows for the possible identification of the key routes by which pathogens are transmitted. It is important to improve solid waste management and disposal, and this can only be achieved by reducing the waste that is generated by households and by encouraging households to practice recycling.

Regardless of the status of the local authority (whether it is a city, town, or village), there is a basic level of waste management services that needs to be provided to all communities. Unfortunately, the low-income areas of any urban areas receive the lowest level of services and experience the most overcrowding.[3] Urbanization has created a huge gap of inequalities and is seen by the inability of local municipalities to respond to the basic service delivery needs for the urban poor residents.[3]

There are no studies on the health and sanitation status and the effects of waste disposal practices in low income settlements in the Cape Winelands region. The only such studies were carried out in settlements in the City of Cape Town.[23,24, 30,31] The resources available to a city differs vastly to that of a rural municipality. There are also large differences in community approaches to sanitation and disposal, so that any studies carried out in the northern provinces may not be applicable to the present study area.

CHAPTER 2

Study Aims, Design and Methods

2.1 Aim and objectives of the present study

Study aim:

To survey the hygiene, sanitation, housing, microbial water pollution and waste disposal practices of households in the Mbekweni community and to assess the impact of such practices on the immediate environment by documenting the pollution state.

Objectives:

1. Document the basic epidemiological characteristics of the Mbekweni community.
2. Evaluate the physical living conditions with access to water and sanitation of the sampled dwellings.
3. Examine the reported health symptoms, well-being and sanitation behavior of the participants.
4. Evaluate housing and the relationship between housing and environmental factors.
5. Evaluate the types of waste generated by the inhabitants in the sample.
6. Evaluate the environmental microbial pollution of surface run-off water encountered in the living areas of the sampling units.

2.2 Study design

This descriptive study was a cross-sectional, community-based survey that consisted the clusters of families occupying the 119 dwellings. The 119 dwellings had 512 occupants. The study was conducted over a 4-month period starting from February 2016 to May 2016. The study consisted of mixed housing types such as shacks, government funded houses, and houses that the residents had built themselves.

2.3 Background to the Methodology

Descriptive research seeks to describe a population, situation, or phenomenon as accurately and objectively as possible. It can provide answers to questions on the nature or extent of problems but not why those problems arose. It can, however, give strong indications as to

which factors should be investigated further to determine cause and effect. A study aim that investigates cause-and-effect however requires an experimental research design.[121]

A descriptive research design can use a wide variety of quantitative and qualitative methods to investigate one or more variables. Unlike in experimental research, the researcher does not control or manipulate any of the variables, but only observes and measures them.[121]

The most useful descriptive designs when studying community-based problems is a survey. Such an approach can gather large amounts of data in order to identify trends, patterns and just as important - outliers not fitting in with the average patterns obtained.[121] Therefore, for the present study, a community-based survey method was selected. The importance of choosing the right methodology is crucial to ensure that the study design is representative of the greater population to be studied and that the study goals are achieved.[122]

The current study investigated the waste disposal practices with emphasis on the health and sanitation status of a particular low-income community. All respondents met the study inclusion or exclusion criteria and participation was voluntary.[123] The design allowed wide coverage of the demographics, domicile, waste and waste disposal as well as health and hygiene aspects of the community while still staying inside the financial resources available. The health survey methodology is a crucial feature in the field of epidemiology especially when conducting research in developing states.[122]

All cross-sectional designs have limitations such as the fact that the approach is a once off "measurement of exposure and outcome; it becomes difficult to derive casual relationships.[123] The face-to-face interview usually consumes a lot of time and often can be costly.[122] The response rate is not fixed and it differs by style of data collection, there are various factors that can affect the response rate such as the presence of the interviewer when conducting face-to-face interviews.[122] The sampling procedure is crucial to fulfil the requirement that the survey represents an accurate picture of the situation in that community. The survey method chosen for this study made use of questionnaires designed for a selected topic to question individuals and record their responses.[124] There are various way to administer surveys, e.g. making use of e-mail, telephonic conversations, the internet or lastly in person interviews.[124]

In this study, in-person interviews were chosen. Face-to-face interviews often produce a fairly high response rate of approximately 80%.[122,124] A personal interview can be administered anywhere and it gives the researcher the opportunity to observe the reactions of the respondent.[124] Another advantage of this method is that it allows one to interact and engage with the respondent and the respondents normally more keen to give their time to answer the questions.[124] There are advantages to using a survey approach; one being that is allows the researchers to study larger population groups/samples.[124] Visiting the respondents in their homes also allow the study interviewer the opportunity to observe the real state of domestic sanitation as opposed to what the respondents' answers reflect.

2.3.1 Survey construction

Whole populations are rarely surveyed and thus a sample from the population is usually chosen.[124] The sample was selected to represent the population as best as resources would allow.[124] Randomisation of the dwellings selected during the sample procedure was very important in order to safeguard against selection bias and allow for valid conclusions.[122] In survey sampling design there are only these two requirements - representativity and a large enough sample to allow exceptions or minority groups to havesome represntation. There is no statistical sampling calculation possible since there is no hypothesis involved.

2.4 Background to the investigation

The study followed four phases. Phase 1 involved the field work of visiting the community and conducting the survey from February 2016 to May 2016 at Mbekweni community in Paarl. Phase 2 comprised water collection from the various location points. The samples were sent for analysis at the Mérieux NutriSciences Laboratory. Phase 3 involved capturing the and sorting the data. Phase 4 comprised the data analysis by Centre of Statistical Consultations at Stellenbosch University for Statistical Analysis.

2.4.1 Sampling sites

When selecting sites for the present study, the investigator together with the supervisor and co-supervisor visited the community to assess whether the community met certain selection criteria. The selection criteria used for the study sites were as follows:

- Three different types of housing to be included: Shacks (informal housing), low-cost houses ("RDP type, now also called BNG houses"), and middle-income (formal) houses.
- Sections within the Mbekweni community that are at least three years old or that have been there long enough for possible structural and infrastructure problems to become visible.

2.5 Sample strategy and size

A systematic sampling approach with random starting points was used in this study. This method was employed to ensure that there is no bias in the sample population by giving every member an equal and unbiased chance to be included in the study. To achieve this sampling procedure, the streets were randomly selected across the Mbekweni community. Every 10^{th} dwelling on the street was selected and asked to partake in the research survey. This was done to obtain a random 10% selection of the different types of housing present in this community. The survey covered 119 dwellings housing 512 inhabitants.

There is no statistical sample size calculations involved an a survey, the only requirement that must be met is that the sample is representative of the target population and the area surveyed. This is best achieved by a systematic sampling procedure with a random starting point so that randomisation is an element of the sampling. This guards against selection bias. The number of sampling units (dwellings in the case of the present study) is usually a compromise between the requirement for representativity and the resources of the investigator. During 2011 the Drakenstein Municipality estimated that Mbekweni has about 10 000 inhabitants but that was not formally verifiable and not published (Barnes, J. personal communication, 2020). The 512 inhabitants covered by the present study thus constitute a 5% sample of the last known number of inhabitants. The total number of 'streets' in the township is not known and in the informal sections of the township these pathways change, depending on flood damage, encroachment from shack building, etc. As the investigator encountered each street or pathway in the selected areas, the starting point along the route was randomly selected and the sampling carried out as described.

When the owner of the dwelling was not willing to participate in the study, the next dwelling was approached. This was done until a willing participant was found and then the next nine houses were skipped. The sampling in such a study design is intended to obtain a true picture of the conditions to be studied as truthfully possible without the necessity of obtaining data from an entire population, for reasons of practicality and cost-effectiveness. All dwellings on a selected plot (main house and informal dwellings in the back yard) were included but recorded separately. The fieldwork for this study was conducted over a period of 4 months, from February 2016 till May 2016 and the interviews took on average 30 minutes per household.

The principal investigator collected the relevant data by means of structured interviews (Appendix A). To inspect the condition of the sanitation arrangements in the home, there was a visual inspection done on the premises. The results that were obtained were entered on a data capture sheet (Appendix B). For the research to yield reliable results the respondents needed to be able to interpret the questions correctly. In this study, the questions were constructed using simple language as to eliminate any confusion.

There were three identical questionnaires in the three official Western Cape languages, English, Afrikaans and IsiXhosa to accommodate every individual in this community. The survey included different types of survey questions, for example open-ended, closed-ended, partially open-ended and Likert rating scale [124]. There were no misinterpreted questions as the isiXhosa questionnaire was transcribed by an isiXhosa teacher at Ihlumelo Senior Secondary school to ensure that all participants fully understood the survey questions. There were no additional problems relating to the questionnaire and therefore no modifications to the questionnaire were made.

The structured interviews, thus each participant was given the same questions using the identical wording and the same order [125] were conducted to the head of the house. In cases where the head of the house was not available, the next most senior person of the household was interviewed. When the above-mentioned candidates were not available, the next eligible person in the household was interviewed.

The investigator first introduced herself to the participant and explained the objectives of the study in the home language or preferred language (English, Afrikaans, or isiXhosa). Typical

problems that may be encountered in personal interviews is the lack of anonymity and time constraint.[124] To overcome these issues and make the respondents more at ease to participate in the survey, anonymity was ensured by making sure that no respondent provides their name on the questionnaire. The consent form was explained in detail and any questions that the candidate had was addressed (Appendix C). Once the respondent had signed consent, the consent form placed in a sealed box with a postal slot designated only for the consent form. The investigator conducted the interview with the participant where they went into detail with each question and the answers given by the participant was recorded. The respondents could take a break at any point should they felt tired or needed a break and the researcher resumed the interview at their convenience. The participant could also stop the interview at any point if they felt uncomfortable with the line of questioning. After the interview was completed, the questionnaire and checklist (Appendix A and B) that included the responses of the participant and the evaluation of the premises was placed in a sealed box designated for completed questionnaires and checklist, each questionnaire and checklist had a plot number in the corner of the document as to keep track of the answers. This not be traced to their identity on the consent form.

The questionnaire consisted of the following sections: demographics, domicile, waste, disposal, lastly health and hygiene. The inspection of the dwelling and yard concentrated on the sanitation infrastructure and condition of the premises. The toilet was classified as non-operational when one of the following was observed, if the toilet was blocked, if the toilet could not flush, if the toilet had serious leaks or had a severely cracked cistern or bowl. The sanitary condition of the yard was classified as poor when one or more of the following was observed: if the was broken glass present in the yard, if there was solid waste lying around the yard, excreta/ animal waste, and the presence of puddles of dirty water, overflowing waste bins, overflowing or dirty drains.

After the completion of the structured interviews, run-off water samples were collected from different location points inside the community were the structured interviews were conducted. The water samples were thereafter analyzed microbiologically for microbial faecal contamination at an accredited laboratory. The samples were collected in the internationally approved way as stated by the WHO [126] and transported on ice to the Mérieux NutriSciences Laboratory for microbiological testing[9]. This laboratory is SANAS accredited for the analyses requested.

The collection of water samples was done to gain an overall impression of the faecal contamination of free-running water within the community surrounding the sampled plots.[127]

2.6 Research Tools

In community health research, the use of surveys or structured interviews is one of the most effective tools to use.[122] The findings in many community health research studies are entirely or partly based on the data obtained by means of surveys or structured interviews (verbal questionnaires) with the data captured on a data capture form.[122]

A sizeable amount of qualitative data had been documented during the interviews and illustrated in abbreviated form on the data capture sheet for each respondent. During the collection of this qualitative data, the respondent could express him/herself freely with any issues he/she felt was important (these varied from discussing their health to their daily needs).

The questionnaire used and the observations noted during the data capture visit at each dwelling were based on those used by Govender et al.[23,24] in housing studies in the City of Cape Town. Small adaptations were made for local conditions. The research tools were not validated as no gold standard is available to test the data obtained for accuracy and repeatability. Doing validation of the research tools from scratch would entail an investigation that is outside the scope of the present study requirements.

The investigator carried out the data collection for the study and the supervisors oversaw the data collection process.

2.7 Water sampling

Environmental water samples were collected at the different locations in each community. Since the water came from informal discarding of wastewater or greywater as well as leaking municipal sewer systems, there was no formal sampling layout or plan. Water was taken where it could be found in sufficient quantities. Dirty water running along the streets in this community was taken for investigation. The site selection was constrained by the places that the investigator could find water, but every effort was made to spread the samples throughout

the area. The investigator collected the water using sterile water bottles that were supplied by Mérieux NutriSciences Laboratory. Approximately 250ml of environmental water was collected from the 12 location points in the community for further microbial testing. The sterile water bottle was then sealed and labelled and immediately placed on ice in a cooler box.

After the selection of the water samples at the different location points, the water was transported to Mérieux NutriSciences Laboratory in Cape Town for water analysis. This was done in order to assess the water quality of the surrounding environment as an indication of infection risk[128]. The samples reached the laboratory within an hour of being taken.

Indicator organisms are routinely used when doing water analysis to identify infection risk.[129] The presence of indicator organisms in water is usually a sign that faecal contamination is present, when the indicator organism is present, at large quantities; it is usually an indication that the contamination is recent and hazardous.[129] Total coliforms were previously used as indicator organisms[129] but are now deemed inaccurate. Total coliform represents a large group of gram-negative rod-shaped bacteria that share numerous characteristics but that do not reflect faecal contamination well[129] The thermotolerant coliforms and bacteria that are of faecal origin.[129] A subgroup of the thermotolerant coliforms, namely *E.coli* is used as an indicator organism of choice to detect the levels of contamination and hygienic condition of water.[130] This was chosen as indicator in the present study.

2.8 Data analysis

Data obtained by the questionnaires and checklists were captured into a Microsoft Excel spreadsheet by the principal investigator and was overseen by the supervisor. All the information given by the respondents were captured exactly as they were. After capturing the information, the investigator cleaned up the data, this entailed categorizing the data and checking the accuracy of the capturing. In areas where the respondents did not provide a response to a question or answered that the question did not pertain to their situation, that response was labelled as being non-applicable (N/A).

After the cleaning and filtering of the data, the investigator created a data report document. In this document all the respondent's information was captured in forms of Tables and bar graphs that mirrored the questionnaire, and percentages were determined in areas were needed. The

principal investigator then met with Professor M. Kidd of the Centre for Statistical Services at the University of Stellenbosch for statistical consultation. Statistical analysis was carried out on the data and Chi Square tests as well as a Fishers' exact tests were performed to determine any internal statistical differences for selected variables in the study. There were no continuous variables deemed important to analyse and the study design was a cross-sectional one. Thus, Prof Kidd only used non-parametric statistical analyses.

The data entry and reporting of the results was monitored by the study supervisor to ensure the data integrity**.** After statistical analysis, a summary of the statistics report was sent to the principal investigator. The principal investigator then analysed the report document and filtered the document to match the corresponding questions in the questionnaire and then captured and interpreted the data in the results section where the study supervisor kept close observation of the data.

2.9 Ethical aspect of the study

The study was approved on 21 January 2016 by the Health Research Ethics Committee 1 of the Faculty of Medicine and Health Sciences of Stellenbosch University. The study was conducted according to the ethical guidelines and principles of the International Declaration of Helsinki,[131] South African Guidelines for Good Clinical Practice and the Ethical Guidelines for Research of the South African Medical Research Council (SA MRC).[132] The ethics reference number for this is S15/09/195.

National Research Foundation (NRF) funding was secured for the study under the Thuthuka grant instrument. All interviews were carried out by the investigator (who is currently a master's candidate for this study) on the inhabitants of this community and were done anonymously.

The purpose of the study was explained to the participant in his or her home language (the investigator could communicate in all three languages). A consent form in the home language (isiXhosa, English, or Afrikaans) of the respondent was completed (Appendix A). The information obtained from the questionnaires was reported in grouped data form and the anonymity of the respondents was maintained throughout the process. The study did not pose any risk to any of the participants. The participants of the study were not paid for their time

and were given the option of stopping the interview at any point in time when they felt uncomfortable with the line of questioning.

A short report from the thesis will be made available to the Drakenstein Municipality, and other interested parties. It is envisaged that officials at the municipality will find the information gathered from the study useful when planning for services rendered to the Mbekweni community. As a result, the participants in the study and the larger community will benefit by the research.

Chapter 3

Results of the Study

This section documents the findings obtained from the survey conducted, as well as the water samples collected. The survey consisted of four sections:

- Section A which is the representation of the sample population demographics,
- Section B explored the domicile of the sample population,
- Section C investigated the waste and disposal practices of the sample population, and lastly
- Section D reviewed the health and hygiene practices of the sample population.

Survey data was collected over 4 months, from February 2016 to May 2016.

All the participants whose dwellings were selected during the systematic sampling procedure and who were home at the time of the visit gave consent and completed the questionnaire to the best of their abilities. A total of 200 plots were visited and out of the 200 plots, only 119 plots took part in the survey (response rate = 59.5%), the rest either declined or were not home. The study population size was 512 inhabitants residing in 117 dwellings, although the initial number of plots that participated in the study was 119, only 117 dwellings fully completed the questionnaires. Two questionnaires were left incomplete.

3.1 Section A: Demographics, socio-economic factors and health

Table 3.1: Total number of household inhabitants

Age	**Number of Respondents**	**Number of inhabitants**
1-11 Months	N/A	6
1-10 years	N/A	81
11-20 years	8	126
21-30 years	28	118
31-40 years	43	82
41-50 years	20	43
51-60 years	11	27
61-70 years	5	16
71-80 years	4	5
81-90 years	-	1
91-100 years	-	-
Unsure	-	7
Total	**119**	**512**

N/A = Not applicable

The age distribution of the respondents (Table 3.1) indicated that the respondents were mainly from the young adult age group, while range was wide: 17 years to 77 years. The sample inhabitants as seen in Table 3.2 was made up of 512 inhabitants, most of the inhabitants fell between the ages of 11-30 years.

Table 3.2: Central tendency and distribution of age of Mbekweni study population (years)

Age (years)		Size (n)	Median	Mean	Standard deviation (sd)	Minimum (min)	Maximum (max)	25th Percentile	75th Percentile
Respondents		117	36	37.9	13.36	17	77	28	44
Study Population		512	23	26.1	16.76	0.25	83	14	36

The respondents had a mean age of 38 years (Table 3.2). Only 117 respondents completed the survey and a quarter of the respondents were ≤28 years old while three quarters of the respondents were ≤44 years of age (Table 3.2). From the 512 inhabitants, a quarter of the inhabitants were <14 years of age and three quarters of the inhabitants were ≤ 36 years of age (Table 3.2). The inhabitants had a mean of 26 years old and has a median of 23 years of age and a standard deviation of 16.75 ages (Table 3.2). The youngest person in this sample was 0.25 months old and the oldest was 83 years old (Table 3.2).

Table 3.3: Gender analysis of both respondents and inhabitants

Gender	**Respondents**		**Inhabitants**	
	No.	**%**	**No.**	**%**
Female	82	70	294	57.4
Male	35	30	216	42.2
N/A (Unsure)	-	-	2	0.4
Total	**117**	**-**	**512**	**-**
Total percentage	**-**	**100**	**-**	**100**

Seen from Table 3.3, the females outweigh the males in this sample population, 70% of the respondents were females and 57.4% of the inhabitants were also female.

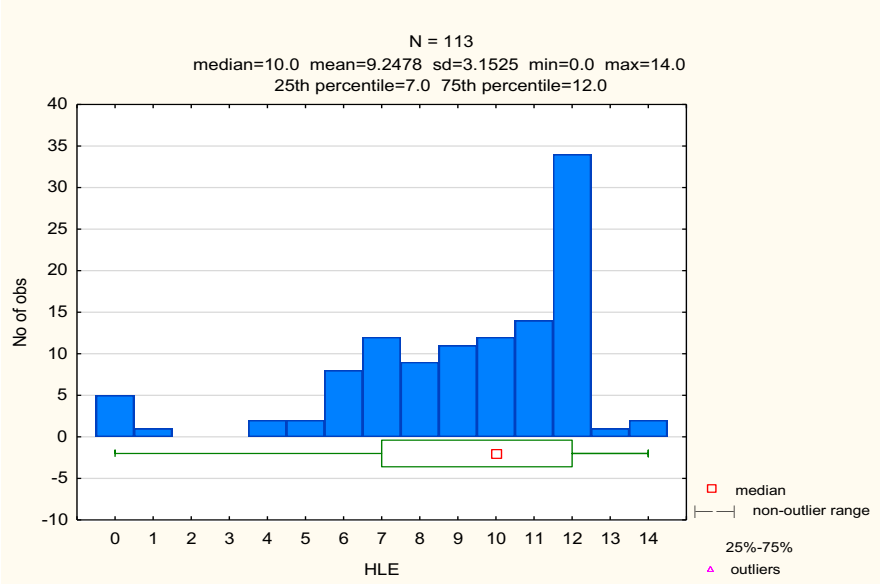

Figure 3.1: Educational level of the sample community (x-axis represents highest level of education obtained, i.e. years of school or post-school education completed)

Figure 3.1 shows that the community had a wide educational range reaching up to tertiary level. Three quarters of the community completed grade 12 and a quarter went as far as completing grade 7. The average grade completed by this community was grade 9.

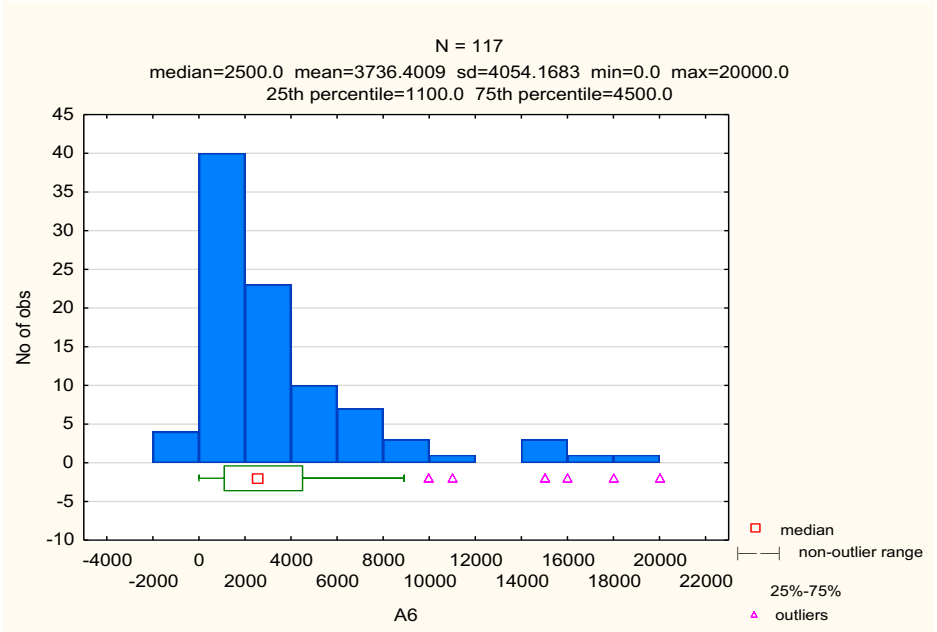

Figure 3.2: **Household income (**in Rand per month)

Three quarters of the community earned in the range of R4 500 per month, while 25% earned <R1 100 per month. The households of this community had an average monthly income of R3736.4 (Figure 3.2).

Table 3.4: Marital status of respondents

Status	Number of respondents	Percentage (%)
Single	78	67
Married	34	29
Widowed	5	4
Total	**117**	**100**

Table 3.4 represents the marital status of the respondents. Most of the respondents were single (67%), only 29% of the respondents were formally married and 4% of the respondents were widowed.

Table 3.5: Number of people receiving social grants in a household

Number of people with access to social grant in the household	Respondents response	Percentage (%)
0	67	57.3
1	30	25.6
2	-	-
3	16	13.7
4	3	2.6
5	1	0.9
Total	**117**	**100.0**

A reported 57% of the respondents stated they had no access to social grants (Table 3.5). Twenty-six percent of the respondents indicated that they had at least one person in their households receiving a social grant and 14% of the respondents reported having up to three people accessing a social grant in the home.

Table 3.6: **Health behaviour reported by the different households** (please refer to Appendix B for exact phrasing of the questions)

Health behaviour reported	**Shack dwellers (number)**	**Formal house (number)**	**p-value (Chi square test)**
Washing hands after using bathroom	53	52	0.436
Can get sick from dirty toilet	52	52	0.661
Get disease from dirty home	54	52	0.691
Get disease from waste outside your home	52	50	0.963
Get sick from drinking river water	54	48	0.889
Get sick from playing near the river	49	43	0.626
Easy to clean your home	25	10	0.003*
Afford hand detergent	45	51	0.021*
Afford body soap	55	54	0.675
Presence of rats	49	16	0.000*
Presence of cockroaches	45	35	0.072
Presence of flies	50	35	0.023*

***Significant at the level of p<0.05**

Shack dwellers often had difficulty in keeping their households clean (Table 3.6). A reported 45% of shack respondents admitted to having difficulty in maintaining household cleanliness as compared to the 19% reported by the respondents living in formal houses (p=0.003).

There was a significant difference between shack dweller (22%) and inhabitants of formal houses (7%) in how many households could not afford hand detergents (p= 0.02).

There is a significant difference reported for the presence of rats between the two housing types. Eighty-eight percent of shack respondents admitted to having rats in their household as compared to the 31% of respondents living in a formal house (p=0.00).

3.2 Section B: Domicile of participants in the study

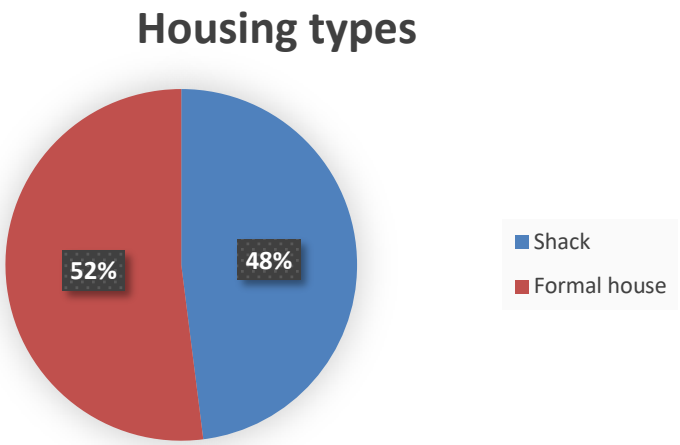

Figure 3.3: The housing types of the sample population

Figure 3.3 displays the housing types of the respondents. Of the 117 residential plots visited, 56 (48%) had houses that were made of brick and mortar, while 61 (52%) of the plots had shacks.

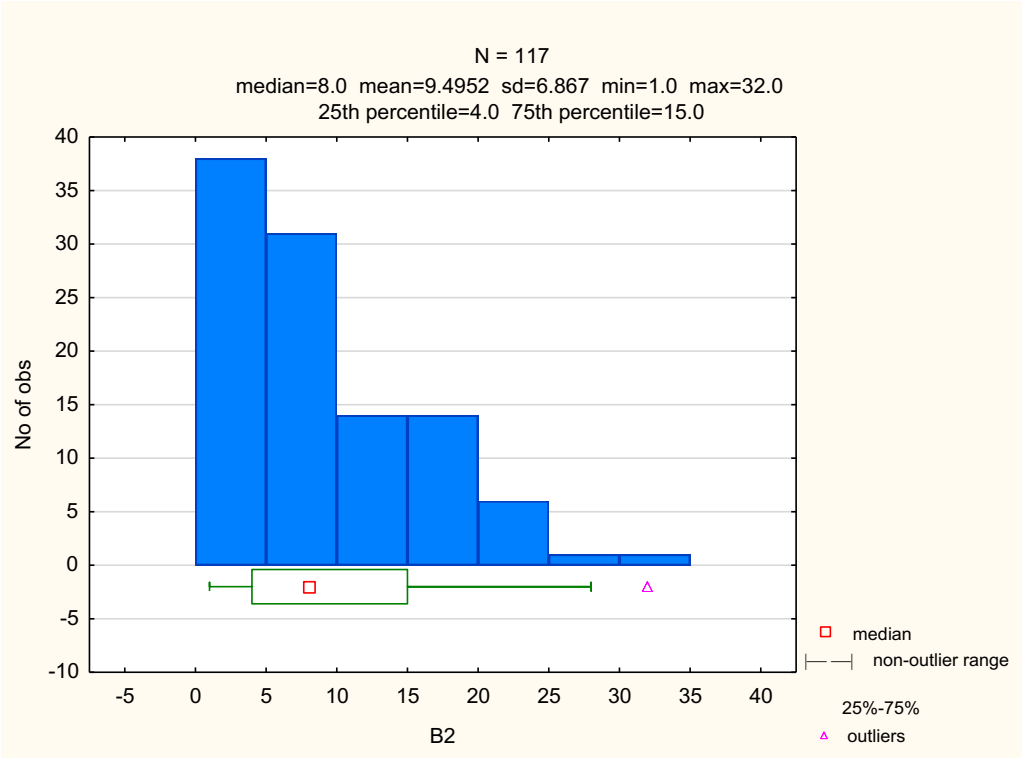

Figure 3.4: Number of years lived in the home

The average (median) number of years people occupied the house was 8 years, with a mean of 9.5 years, and a standard deviation of 6.9 years (Figure 3.4). The maximum stay in their homes was 32 years. Most of the sample population have lived in their homes for 15 years (Figure 3.4) and only 25% of the respondents indicated staying in their homes for shorter than 4 years.

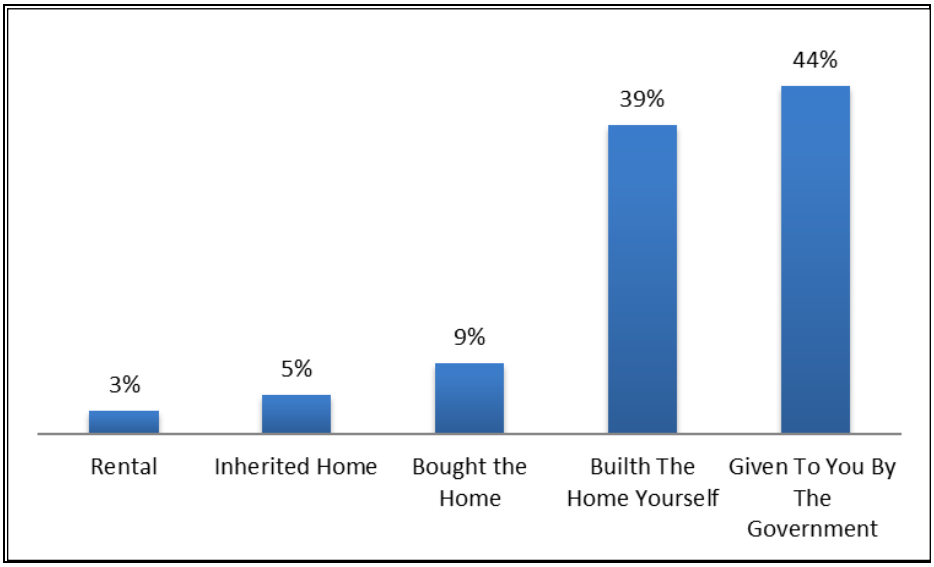

Figure 3.5: How the respondents acquired their homes

A reported 44% of respondents indicated that they were given their homes by the government (Figure 3.5). These refer to the so-called RDP (Reconstruction and Development) houses, now called BNG (Breaking New Ground) houses.

The respondents were asked if they had applied to the council for a house, about 46% of them stated yes, while 34% of them stated that the question did not apply for them or their circumstances, and 20% said no.

Table 3.7.1: Location of taps, toilets, and bathroom facilities within shack houses of the community.

Location	**Tap**		**Toilet**		**Bathroom/washing**	
	No.	**%**	**No.**	**%**	**No.**	**%**
Communal	53	44.5	52	43.6	-	-
Outside the home	7	5.8	7	5.8	3	3
Inside the home	1	0.8	3	2.5	17	14
Inside and outside the home	1	0.8	-	-		-
None	1	0.8	1	0.8	43	36
Total percentage	**-**	**53**	**-**	**53**	**-**	**53**

Table 3.7.2: Location of taps, toilets, and bathroom facilities within formal houses of the community

Location	**Tap**		**Toilet**		**Bathroom/washing**	
	No.	**%**	**No.**	**%**	**No.**	**%**
Communal	1	0.8	-	-	-	-
Outside the home	6	5	14	12	-	-
Inside the home	34	28.5	30	25	42	35
Inside and outside the home	15	12.6	12	10	-	-
None	-	-	-	-	14	12
Total percentage	**-**	**47**	**-**	**47**	**-**	**47**

Analysis in Table 3.7 showed the location of taps, toilets and bathroom facilities of the two housing types. In Table 3.7.1 it is observed that approximately 45% of the shack dwellers lacked tap facilities located in their households and as a result made use of communal taps. This was in contrast to the formal dwellers results seen in Table 3.7.2 where only 1% of the residents made use of communal taps. The rest of the formal residents had taps located inside or outside their homes with the majority (29%) being located inside the homes.

The toilet facilities were also lacking amongst shack dwellers, seen in Table 3.7.1 approximately 44% of the residents lacked toilet facilities in their households and as results made use of communal toilets. The situation for formal residents was different as observed in Table 3.7.2. Most formal dwellers had toilet facilities located inside their homes (25%) and none used communal toilets.

Analysis on the bathroom facilities as revealed in Table 3.7.1 for shack residents showed that 36% of the residents lacked bathroom facilities and as a result made use of a portable small bathtub to bath, unlike the 35% formal residents that reported to having bathroom facilities (Table 3.7.2).

Table 3.8.1: Water and electricity status of shacks.

Respondents response	**Does the home have electricity**		**Do you pay for electricity**		**Do you pay for water**	
	No.	**%**	**No.**	**%**	**No.**	**%**
Yes	21	18				
No	42	35				
Yes			24	20		
No			39	33		
Yes					8	7
No					53	45
N/A					2	2
Total percentage	**-**	**53**	**-**	**53**	**-**	**54**

Table 3.8.2: Water and electricity status of formal houses.

Respondents response	**Does the home have electricity**		**Do you pay for electricity**		**Do you pay for water**	
	No.	**%**	**No.**	**%**	**No.**	**%**
Yes	56	47				
No	-	-				
Yes			52	43.6		
No			2	1.7		
Sometimes			2	1.7		
Yes					43	36
No					3	2.5
Sometimes					8	6.7
Did not say					1	0.8
Total percentage	**-**	**47**	**-**	**47**	**-**	**46**

Table 3.8 evaluated the water and electricity status, seen in Table 3.8.1 was that 35% of the shack dwellers lacked electricity. When asked if they paid for electricity and water, only 20% stated yes for electricity and 7% stated yes for water. Some of the shack resident had illegal electrical connections and some made use of candles, gas stoves or paraffin.

This was not the case for formal residents, reported in Table 3.8.2 was that all the formal dwellers (47%) had electricity. Approximately 44% of the formal residents paid for electricity and only 36% paid for water.

3.3 Section C: Waste and waste disposal

Due to the complexity of the type of waste generated within the community, the types of wastes generated were arranged into four categories based on their type of pollution. The four categories were:

- **Category 1 Nonspecific**. This category comprises the things that the respondents were unsure of how to describe the waste, or when they had no response to the question or when they keep or sell the items.

- **Category 2** referred to as confined collections or waste that is kept together in a dedicated space or container. This group comprises the waste that the respondents stored in plastic bags, outside waste bins, small dustbins, municipal big waste bins, communal bins, or skips, reused for other things, donated etc.
- **Category 3** referred to the environmental pollution category. This group included the things that contributed to the pollution of the environment due to the way the community handled the waste. These items typically ended up in informal waste dumping sites, outside on the grassed areas or open veld, waste found behind the train station, behind the river, waste left outside on the street or on the opposite sidewalks, etc.
- **Category 4** referred to water pollution and all the waste that contribute to the pollution of the water, such as disposing things down the drain, down the toilet, down the drain of the communal taps, by the river, down the sink etc.

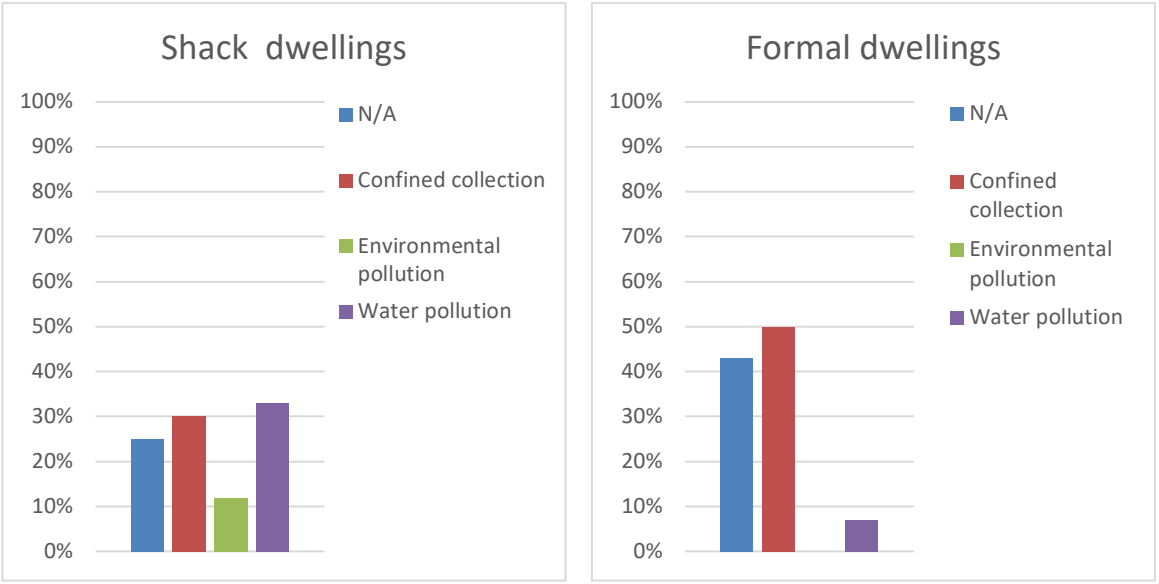

Figure 3.6: Disposal of dirty nappies (Question C24) among the different housing types (N/A means not applicable or not answered)

In Figure 3.6 a Chi-square test, p=0.0001 revealed that there is a significant difference in the disposal patterns of dirty nappies between the two housing types. Shack dwellers mostly consisted of 30% category 2, 33% category 4 and 12% category 3, while formal houses consisted of 50% category 2, and 7% category 4.

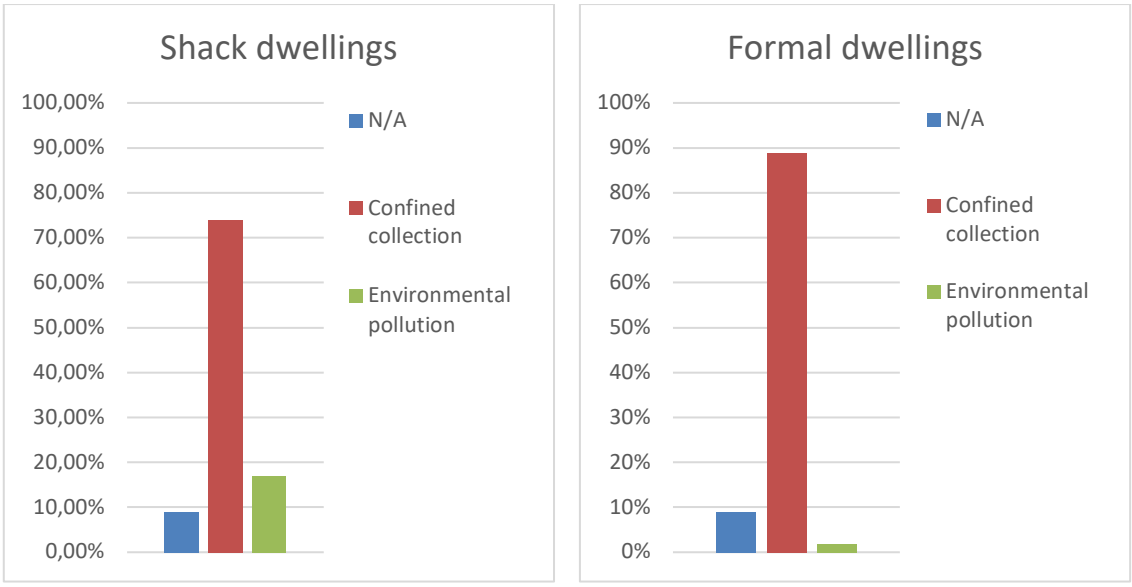

Figure 3.7: Disposal of broken glass between the different housing types (N/A means not applicable or not answered)

Seventy-four percent of shack dwellers reported disposal of broken glass in a confined collection (i.e. the safe option), while 89% of respondents from formal houses reported disposal of broken glass into confined containers. Formal houses reported 2% environmental pollution, while shack dwellers reported 17%. The disposal patterns for broken glass were statistically significantly different a Chi square test, p=0.012 supported this observation (Figure 3.7).

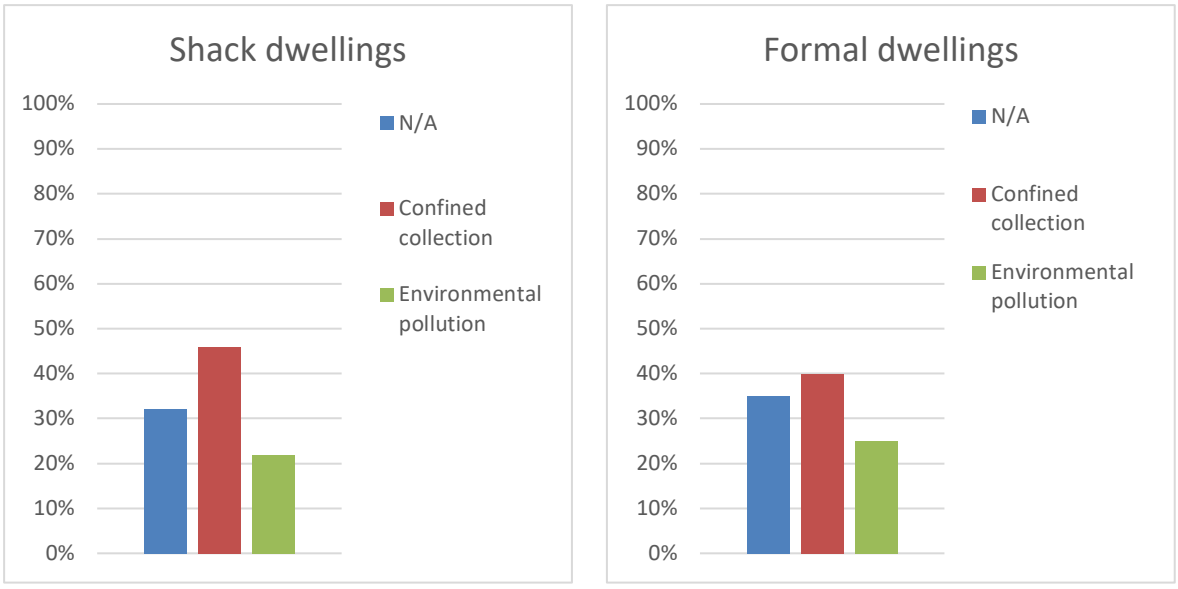

Figure 3.8: Disposal of old furniture among the different housing types (N/A means not applicable or not answered)

Many households possess old, unwanted furniture, and when asked how they dispose of it, 46% of shack dwellers and 40% of formal house residents indicated that they disposed of the unwanted furniture in confined collections. The disposal patterns did not differ significantly (Figure 3.8, a Chic square test, p= 0.816 supported this finding).

Table 3.9: Community waste disposal collection by the local municipality

Respondents response	**Does the municipality collect waste**		**Do you dump waste at local dumping site***		**Do you burn waste**		**Do you recycle waste**	
	No.	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**
Yes	88	77						
No	20	17						
Sometimes	7	6						
Yes			46	40				
No			69	60				
Yes					33	29		
No					81	70		
Sometimes					1	1		
Yes							13	11
No							102	89
Total percentage	**-**	**100**	**-**	**100**	**-**	**100**	**-**	**100**

*These dumping sites are against municipal regulations

The local municipality collects solid waste for a reported 77% of households (Table 3.9). However, 40% of the respondents admitted to dumping on local informal dumping sites also referred to as illegal dumping. Only 11% of the respondents indicated that they are aware of the recycling process and that they do practise it in their households. The remaining 89% had no idea what recycling was and as a result did not practise it in their households (Table 3.9).

Table 3.10.1: Household kitchen questions for shack houses.

Questions	Yes (number)	No (number)	Did not continue
Do you have a kitchen sink	4	58	1
Do you have a kitchen tap	5	57	1
Do you use a basin to wash the dishes	35	26	2
Do you have a kitchen bin	14	48	1

Table 3.10.2: Household kitchen questions for formal houses.

Questions	Yes (number)	No (number)	N/A (number)
Do you have a kitchen sink	49	7	
Do you have a kitchen tap	46	10	
Do you use a basin to wash the dishes	29	14	13
Do you have a kitchen bin	28	27	1

N/A means not applicable or not answered

Table 3.10 is a summary of the answers reported by the respondents when asked about the hardware available in the kitchen, (See Appendix D for the full list of the household kitchen questionnaire). Most of the shack respondents reported that they lacked a kitchen sink and tap (Table 3.10.1). Table 3.10.1 also revealed that most of the shack households used a basin to wash their dishes, while the remainder used small kitchen bowls to wash dishes. Table 3.10.2 shows that most of the formal households had a kitchen sink and tap.

Table 3.11: A description of the various methods of disposal used by the community to discard their dirty water

Substance for disposal	**Down the toilet only (number)**	**Down the drain only (number)**	**Outside on grass or field (number)**	**Outside in storm water drain (number)**	**Down the toilet or down the drain (number)**
Water after bathing	32	60	11	1	-
Dirty water after washing clothes	16	75	15	4	2
Dirty water after household cleaning	17	78	17	3	
Dirty water after floor cleaning	17	79	13	4	
Water after washing nappies	15	54	7	3	
Water after cleaning pets	11	57	7	6	
Water after washing car	4	51	20	7	
Water after washing refuse bin	1	64	20	14	

The analysis in Table 3.11 evaluated the various waste disposal methods in the community. Most residents discarded waste down the drain (Table 3.11). The most frequently used waste disposal method is discarding their waste down the sewerage drain.

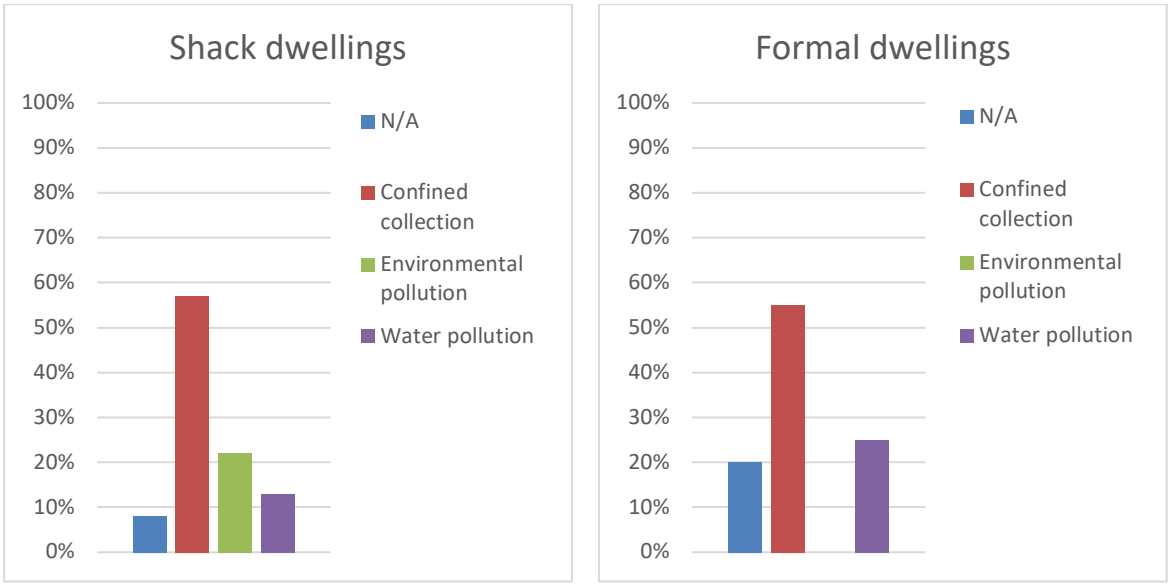

Figure 3.9: Disposal of old medication among the different housing types (N/A means not applicable or not answered)

A statistical comparison as illustrated in Figure 3.9 (a Chi square test, p=0.000) revealed that there was a significant difference in the disposal patterns of old medications used by the two housing types.

Table 3.12: Analysis of the environmental water samples

Sample site	Coliforms (cfu/100 ml)	*E. coli* (cfu/100 ml)
L1	3 900 000	2 300 000
L2	>30 000 000	32 000 000
L3	15 000	2 300
L4	16 000	16 000
L5	29 000	12 500
L6	25 000	8 500
L7	3 200 000	5 000
L8	2 100 000	35 000
L9	10 000	6 700
L10	110 000	*No growth
L11	5 500 000	650 000
L12	170 000	4 100

*Note that a result of 'No growth' should not be interpreted as a zero count, but that the organisms for some reason did not grow in the culture medium provided as part of the

standardised testing. This should be interpreted as an inconclusive result. This happens when there are certain growth inhibition compounds present in the environmental water in the form of pollution.

Environmental water samples were collected at twelve different location spots in the Langabuya area of Mbekweni. Table 3.12 contains the coliform counts and *E. coli* counts. Small water pools were present on the sidewalk of Langabuya Street, and the water was collected at each point. For interpretation: drinking water should not contain any *E. coli* organisms.[133] [128] For recreational contact with environmental water such as rivers, streams or pools, the safe limit for full body contact is 130 cfu/100mL and for intermediate body contact is a maximum of 1000 cfu/100mL.[133] Many of the water samples taken in the street are readily accessible to any passers-by or children. Seen from Table 3.12 the water collected from the nearby streets of the study population far exceed the accepted level of body contact and recreational contact with the environment.

3.4 Section D: Health and Hygiene

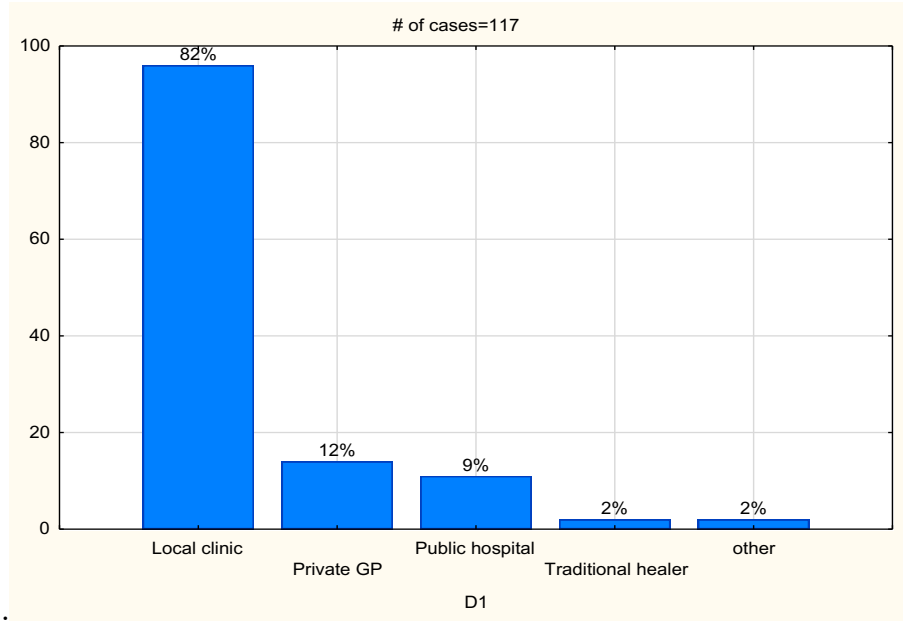

Figure 3.10: The health facilities used by the community

The different health facilities used by the residence of this community are depicted in Fig. 3.10. Eighty one percent of the dwellers walked to their health care facility, while 13% used public taxis, 2% used either walking or a taxi, 4% made use of their own private cars and 1 used the train.

An estimation was made on how much the study population spent to get to the health care facility. The average cost for a person residing in the study area to reach their designated health care facility and back was R27

Table 3.13: In the previous two weeks did you suffer from the following?

Symptom reported	Shack dwellers No.	%	Formal house No.	%	p-value (Chi square test)
Completed prescribed medication	47	88	46	86	0.767
Diarrhoea	13	22	6	11	0.107
Fever	24	41	22	42	0.861
Vomiting	11	19	10	19	0.952
Cramps/Abdominal pain	23	39	13	25	0.131
Eye infection	18	31	14	26	0.549
Headaches	30	50	32	57	0.441
Coughing blood	5	9	1	2	0.092
Itchy skin	18	30	3	6	0.004*
Nausea	13	22	8	15	0.323
Coughing for longer than two weeks	10	17	3	6	0.060
Loss of appetite	14	23	6	11	0.090
Loss of weight	18	30	8	15	0.051
Night sweats	22	37	8	15	0.007*

*** Significant at the level of p<0.05**

The symptoms reported in Table 3.13 were subjected to a Chi Square analysis to see whether there were significant differences between the two types of housing. Itchy skin (p=0.004), night sweats (p=0.007) differed significantly between the inhabitants of these two housing types.

Table 3.14: Health status of the different households

Health status	**Shack dwellers (number)**	**Formal house (number)**	**p-value (Chi square test)**
TB diagnosed cases reported	8	14	0.104
HIV diagnosed cases reported	3	5	0.381
Hospitalisation in the last 6 months	15	12	0.615
Called for an ambulance	17	19	0.542
Satisfied with medication given by clinic/government	44	48	0.319

As demonstrated in Table 3.14, there is no significant difference in the number of health problems reported by the two different housing types. It is worth noting that TB and HIV is commonly underreported in most surveys, this could be the direct result of the social stigma associated with these diseases.

Table 3.15: Bathing frequencies of the different housing types

Frequency of bathing in children	**Shack dwellers (number)**	**Formal house (number)**	**p-value (Chi square test)**
Once a day	29	10	0.0003*
Twice a day	15	32	
When needed	6	8	
Frequency of bathing in adults	**Shack dwellers (number)**	**Formal house (number)**	**p-value (Chi square test)**
Once a day	28	20	0.318
Twice a day	24	31	
When needed	6	5	

*** Significant at the level of p<0.05**

A Chi-Square statistical analysis of a p-value of 0.0003 (Table 3.15) revealed that there is a significant difference in the number of times children are bathed between the two types of housing. Children in formal houses tends to bath more than once a day as compared to the children in shack houses which mostly bath once a day.

Chapter 4

4.1 Discussion

The study included 119 dwellings with 512 inhabitants. The single biggest age group was that of the young adults (Table 3.2). This is in keeping with the Cape Winelands District Municipality Socio-economic profile that has established that the majority of the population in the area was in the age range of 25-29 years.[134] There were more female respondents taking part in the interviews, a ratio of 70:30. This was likely because the interviews took place during the day and more females were at home while more men were out working. Looking at the overall study population however, there was only a small gender difference amongst the total number of inhabitants (Table 3.3) of the dwellings in the study. This finding supports the Cape Winelands District overall sex ratio of less males than females in the district.[134]

Only a few members of the study group completed tertiary education. Over 75% of the study population completed grade 12, this further supports the finding of an 81.2% matric pass rate in 2018 in the Drakenstein municipal area.[134] Members of this community reached grade 9 educational level on average (Figure 3.1). Drakenstein municipality reported a 26% learner dropout rate (enrolled in grade 10 in 2014 but dropped out of the local schools by the time they should have reached grade 12 in 2016).[135] There are various factors that can affect the highest academic status achieved by members of a community, such as overall poverty, access to adequate educational facilities, learner-teacher ratio, and learner-retention rates.[134] Other socio-economic factors that can affect the academic outcome of a community are teenage pregnancies, limited number of no-fee schools, poor households and unemployment.[134]

Most of the study participants received a low monthly income that was barely enough for their day-to-day basic needs (Figure 3.2) and many of the residents (57%) did not have access to social grants (Table3.5). In the Drakenstein Municipality the number of household living in poverty has increased from 2.1% (of the 59774 households) in 2011 to 2.5% (of the 71686 households) in 2016.[135] The Drakenstein municipal area divides household's annual income into three categories; low, middle- and high-income bracket. Poor households are placed in the low-income bracket when households range from no income to just above R50 000 annually (R 4166 per month).[135] In this study a low monthly income averaging R3736.4 per month (Figure 3.2) was observed and as such the community falls under the low-income bracket. This

mean income level places the whole community included in the study area in the low-income bracket.

In Table 3.13 it was evident that the two housing types did not differ much statistically in term of symptoms experienced by the inhabitants over the period of two weeks. This study population has reported 19% gastrointestinal symptoms during the two weeks prior to study investigation (Table 3.13). Ten percent of the sample population reported symptoms that could possibly indicate TB and 8% reported other infections.

Itchy skin and night sweats showed a significant difference amongst the different housing types (Table3.13). Night sweats may be an indication of tuberculosis and the existence of this needs to be followed up by the community health structures in the town. Itchy skin may be due to skin conditions such as scabies or associated with the presence of fleas in the house. This can be an indication of poor household hygiene.

Various health behaviours were examined, and Table 3.6 showed that good hygiene practices were a problem for shack dwellers and that shack dwellers often encountered the presence of rats in their households. Rats frequently feed on refuse and dwell in drains and sewers, so their presence is a strong indication of possible household contamination with pollution from these places.

Environmental hygiene plays a vital role in the prevention of numerous diseases. Unhygienic conditions are visible in communities who live in poverty. Poor health is a common issue in poor communities. Significant progress has been visible in the general area of Drakenstein over the past years; the study population however has not benefited from this progress and as a result inadequate water supply and sanitation and unsatisfactory hygiene behaviour continue to be risk factors for infection of the population living in the study area.[136].

The residents living in shacks could not afford hand detergents, and this can contribute to poor hygiene status. Poor handwashing habits are favourable for the transmission of many infectious diseases, but notably diarrhoeal diseases. Handwashing with soap is vital as it serves as a defence mechanism against the spread of many communicable diseases.[137] The most recent example is the worldwide pandemic of SARS-CoV-2 which causes COVID-19.[138] Although

handwashing does not prevent infection, it does minimize the chance of transferral of the virus, thereby lowering the risk of infection amongst household members.[137]

Fifty-two percent of the participants lived in houses that were constructed with bricks and mortar (Figure 3.3). Many of the residents in these houses had acquired their homes through the government sponsored housing scheme (Figure 3.6). These residents had access to potentially good sanitation and adequate drinking water (Table 3.7.2), which are elements associated with promoting good health. It has to be pointed out though, that the condition of the sanitation fixtures in any dwellings is heavily dependent on the usage and upkeep by the inhabitants of that dwelling.

Access to formal dwellings had increased by 17.2% in 2016.[115] Despite the increase, however, the remaining inhabitants of this community lived in shacks that are constructed from poor building materials, were limited in size and were unsafe (Appendix E). These residents relied on communal tap and toilets (Table 3.7.1) and displayed in Appendix E, these structures were in poor condition, such conditions minimize the promotion of good health. An overcrowded living environment is very common among poor communities. Inadequate housing is common in urban poor communities and is also evident in this study. More than 50% of the respondents complained about the housing structures. Worth noting was that despite there being two different housing types, there were common issues of concern, such as leaking roofs and broken windows. The issue of water entering their homes when it rains was very prominent (illustrated in Appendix E). The leaking roofs resulted in conditions of prolonged damp in the home thereby creating a suitable environment for the growth of filamentous fungi (mold).[139] Under these conditions mold also grows in and on other household contents such as “paper products, cardboard, ceiling tiles and wood products”.[140] Most of the shacks in this community contained at least one of these materials. This is notable given that the link between microbial contaminants and common respiratory conditions (e.g. asthma and allergies) have been well documented.[139] The inability to afford repairs to their homes leads to poor living conditions that adds more strain to their health.

During the interview process, inhabitants had pointed out the issue of broken windows or lack of windows. Figure 3.3 illustrated that 48% of this study sample lived in shacks, and the shacks occupied informal areas of minimal plot size. Structurally the shacks were mostly single rooms or two rooms with only one window or no window (illustrated in Appendix E). This limits

airflow and impairs proper ventilation in these homes. This is aggravated when paraffin stoves are used for cooking inside such homes. The compromised air quality is a source of concern. Damage to the respiratory system can make such a person more susceptible to respiratory diseases. This is especially important in the fight against TB as the bacilli are airborne.

The shacks are built in constricted spaces, many being no bigger than 10 square metres.[135] This causes a highly dense occupancy rate per household. The number of people who stayed in each home far exceeded the available number of rooms. The sharing of cramped space is a reality for most these participants in the study. Such cramped space facilitates the transmission of airborne pathogens such as TB and SARS-CoV-2.

Table 3.7.1 showed that shack residents were reliant on communal taps and toilets, and the functionality of those toilets and taps were not satisfactory (Appendix C.2). The most recent socio-economic profile for Cape Winelands District Municipality indicated that there was still a total of 17 523 households with no access to basic sanitation services within the Cape Winelands District.[134] Such households therefore rely on communal services. [Note: The Drakenstein Municipality is situated within the Cape Winelands District.] This was evident in this study, with an average of 45% of the sample community relying on communal ablution services (Table 3.7.1).

Many of the households that made use of communal ablution services were located near the railway line with the communal toilets located across the street (illustrated in Appendix E). Wastewater from broken toilets leaked out on the streets adding to the polluted water dispersing into the immediate environment. This contaminated water sometimes ran for long distances while any foot traffic crossing these dirty streams of water can eventually take such contamination into the homes of the inhabitants (illustrated in Appendix E). The number of properly functioning communal taps and toilets were not enough to serve the community (see Appendix C2).

Most of the communal taps were not functioning at all while some others in the communal toilet blocks were observed to run continuously as those taps could not shut properly. As a result, water was running all day (illustrated in Appendix E) resulting in huge water losses. Pools of contaminated water were found near all of the communal taps. The people of this community often took their dirty laundry to the local taps to do their washing there (see

Appendix E). The dirty soapy water was discarded right next to the tap area, adding to the dispersal of polluted water.

Most inhabitants without on-site taps collected water in buckets and stored them in their households for their day-to-day needs. While collecting the water, the bucket was usually placed on the contaminated surface and once full, the residents took the bucket with its now contaminated bottom home (Appendix E). The water collection point was not hygienic. Such water ran the risk of being contaminated even before it reached the home. Inadequate water supply has both direct and indirect negative effects on the health of the community.[82] Certain microorganisms are transmitted through drinking water, for example *E. coli,* hepatitis A and Salmonella.[67]

The doors of the communal toilets could not close and the toilets were surrounded by wet mud and polluted pools of sewage-laden water as well as illegal waste dumping (illustrated in Appendix E). For some residents the communal toilets were located far from their home and they had to walk long distances to reach them.

Safety was a concern in this community as attacks often happened at night when residents left their dwellings to go to the toilet. As a result, many residents made use of other alternatives when needing to use a toilet during the night. These alternatives included making use of a small bucket as a form of chamber pot while the contents often got disposed of in inappropriate ways the following morning. The communal toilets were sometimes used for this disposal, but often such disposal happened into the stormwater drains or simply thrown out on the closest open ground. Some of the shack dwellers stated that they were often compelled to use the bushes across the railway line. This is not a safe practice as people crossing the busy railway line are exposed to the risk of being hit by trains or attacked in the overgrowth. It is a place where criminals could hide, and this increases the risk of being attacked or robbed.

According to a media report[141] three residents of the informal settlement of Mbekweni reported that the communal toilets have been malfunctioning for four years and as a result they often had to pour water into the toilet bowls to flush them. There was one communal tap located for five communal toilets (Appendix E). The communal tap was located a few meters from the communal toilets (Appendix E). Due to the limited availability of working taps in the communal sites, most residents tended not to wash their hands after using the toilets.

Improper sewage disposal can cause various health issues in a community. Human excreta contain high counts of various types of pathogens, some of which, when introduced to the environment can remain infectious for a long time.[142] Although disease transmission is regulated by various pathogenic factors and affected by the host traits and behaviour,[142] the presence of pathogens still poses a potential danger to the inhabitants of this community when using inadequate communal toilets. Not only do the inadequate toilets expose humans to sewage, but they also give rise to bad odours and attracts various insect vectors such as flies.

All the formal residents had electricity (Table 3.8.2), however only 18% of shack dwellers in this study had access to electricity (Table 3.8.1). The shack residents who did not have electricity made use of candles, gas stoves or paraffin stoves for their daily needs. The use of open flames for lighting and heating as well as the flammable nature of the informal building materials hugely increase the risk of structural fires. Structural fires are a well-known risk in this community with a high risk of the fire spreading to adjacent structures due to the extremely dense occupancy and the very flammable building materials used through many areas of the neighbourhood. The inhabitants lacking electricity used illegal connections from nearby houses, the checklist indicated that 46 out of the 119 dwellings made use of illegal connections (illustrated in Appendix E).

Seventy-seven percent of the respondents indicated that their local municipality collected their waste. This further supports the socio-economic profile reports of 81.7% refuse removed by the local authorities at least weekly.[134] There are still households lacking municipal bins.

Table 3.9 revealed that 40% of the respondents admitted to dumping their waste on informal dumpsites nearby and 29% of the population went as far as to burn their waste. This dumping of waste on illegal dumping areas contribute to risk of disease, environmental pollution and creates an unpleasant living environment (Appendix E). The illegal dumping of waste on the streets is evidence of poor sanitation behaviour as well as the lack of recycling in this community (Appendix E). Eighty-nine percent of this community reported not recycling waste (Table 3.9). Recycling is an important way of reducing waste and environmental pollution. It is important to separate the waste at the source of origin to ensure the efficiency of recycling. This is however not practised in this community. The waste that lies on these open areas for a long period of time include rotting food, animal waste, dead animals etc. and will harbour

various microorganisms. The children of this community are most likely to encounter these pathogens while playing in the streets (Appendix E).

Lack of proper waste disposal promotes environmental challenges that impact human health, animal health and crucial economic and welfare losses.[143] This study presents various waste streams and pathways of infections, all of which can give rise to communicable diseases if not handled well. These various waste streams can contribute greatly to the spread of diseases by various vectors. Amongst those vectors are birds, flies, cockroaches, and rodents.[143]

The waste pathways increase the degradation of the environment and contributes greatly to polluted surface and ground water as a result of polluted water draining over land as well as leachate.[143] Soil contamination occurs due to direct waste interaction or leachate.[143] Burning of waste [143] results in air pollution. Although air quality was not investigated in this study, poor air quality has been associated with adverse health outcomes with symptoms such nose and throat sensitivity to chronic diseases [144] as well as breathing difficulties and even lung damage. Outdoor air pollution (particularly from smoke from burning amongst others inappropriate materials such as plastic) is a huge environmental health problem for this community.

Due to the infrastructure of the homes, many shack households lacked a basic kitchen containing a kitchen sink, kitchen tap and a proper wastebin (Table 3.10). Alternative methods to cope with this included usage of a small plastic tub to wash the dirty dishes. Such a tub or basin was often also used to wash clothes and even sometimes the bodies of the inhabitants, especially children.

There were no bathing facilities in these shacks (Table 3.7.1). The inhabitants made use of outside toilets and taps and small washing bathtub to wash their bodies. Most of the respondents (60 respondents) stated that they disposed of their bathing water down the stormwater drain, and a small volume (11 respondents) disposed of dirty water (also called grey water) outside on the grass or street, thereby adding to environmental pollution (Table 3.11). The practice of good personal hygiene such as bathing on a regular basis, washing of hands after going to the toilet and washing of hands with soap before making meals will help to reduce the risk of pathogenic microorganisms entering the body,[145] The present study highlighted the difficulty of practicing good personal hygiene for this community.

External disposal of wastewater was evaluated and recorded in Table 3.11. The method of disposal used by most dwellers was the disposal of grey water down the storm water drain, or down the toilet. It should be noted that 10-15 of the respondents dispose of the wastewater outside on the open grass, usually across the street or even right in front of their yard or down the street. This adds to the contamination burden on the environment and further promotes environmental degradation.

The water collected from the various location points in this community tested positive for *E. coli* (Table 3.12). The organism counts in some of those samples exceed the values usually given for raw sewerage, namely 10^6 to 10^7 *E. coli* organisms per 100 ml water.[127]

The improper waste disposal affected the quality of environmental water in the vicinity of the settlement. *E. coli* is a well-known indicator of sewage or faecal contamination in water (Table 3.12). *E. coli* is one of the most common bacteria that are associated with diarrhoeal disease. Although many *E. coli* strains are non-pathogenic, there are pathogenic strains that are normally found in surface waters contaminated with faeces. This can originate from municipal wastewater discharges, storm water runoff, septic leachate, and animal waste. The high *E. coli* counts of the water present in the streets consist a risk to human health and such water is not safe for any human contact. The members of this community are however constantly exposed to pollution that contain diarrhoeal organisms. Children were observed playing in or near this water. Young children are particularly susceptible to waterborne infections since their immune systems are not yet fully developed.

This highly contaminated water drains to the Berg River via formal stormwater channels as well as informal drainage ditches. This river is the main source of irrigation water for a large downstream agricultural industry producing, inter alia, fruit and vegetables for overseas markets as well as for local consumption. Thus, the contamination runs the risk of being "exported" to consumers of such products living far away from the source of the pollution. This illustrates the ripple effect of the poor sanitation infrastructure and the lack of attention to inappropriate behaviour on the part of the Mbekweni community

The people of this community can handle their waste better if they were better informed of the risks as well as having recourse to alternative methods of disposal. This study also highlighted various infectious pathways that the community must pay attention to avoid the spread of

communicable diseases. The environment must be kept clean and healthy in order to promote good health.[67] To maintain a healthy environment entails adequate water supply, adequate disposal of liquid and solid waste, the practice of good personal hygiene, a healthy house and community health awareness.[67]

The formal aim of this study was to survey the hygiene, sanitation, and waste disposal practices of households in the Mbekweni community and to assess the impact of such practices on the immediate environment by documenting the pollution state. The study also evaluated the difference in waste disposal patterns of this community. The study also evaluated the linkage between health outcome and waste management. This is a mixed housing community which allowed for the investigation of the inhabitants occupying different housing types.

The study investigated the relationship between waste management and health effects; however, the study could not evaluate the precise contribution of the various waste types and the pathogenic microorganisms present in the community. The study did not evaluate the precise pathways of infections from the environment into the households.

When evaluating health effects, it is important to evaluate the health profile (notably chronic or serious long-term conditions) of the community. Due to resource and time constraints that was not evaluated. The only two conditions asked about as indicators of chronic or serious long-term conditions were TB and HIV/AIDS.

The specific contributions of improper waste disposal on the health of the study population could not be quantified in such a descriptive survey.

The study covered only one mixed formal and informal housing area in the Municipality of Drakenstein. Mbekweni is by far the largest such a settlement and in order to mitigate this shortcoming, care was taken to obtain a proper representative sample.

There are always limitations to any community-based survey. Some respondents may not wish to disclose sensitive information, while others may simply not be motivated enough to provide accurate in-depth answers. In some cases, the respondent may simply not know the information required. These shortcomings are addressed to some extent by including as large a sample as

resources and time will allow. These limitations however do not invalidate the findings of this study presented above.

The dynamics of improper waste disposal and infectious diseases was not fully explored in the present survey. With the annual increase in waste generation and urbanization, this facet needs to be further explored. The role of household waste disposal and what actions or habits are the most dangerous needs to be investigated further. Pathways needs to be investigated to fully understand the linkage of improper waste disposal and health effects. In this study it is evident that different households handle waste differently. The different types of waste streams involved and their health implications are unknown.

There are various pathways in which the people of this community are exposed to pathogenic microorganism. Various points of transmissibility are highlighted in this study, that is how these microorganisms can spread from person to person and how the residents can carry these pathogens outside the community.

Enormous environmental pollution is observed in this study such as the poor water quality, high levels of litter, and sewage spilling does not support the high level of rubbish removal indicated by the sample population. There are various blocked drains due to the litter that gets into the sewer system causing them to overflow. These signs are an indication that the community is inappropriately disposing their waste and as a direct result are polluting their own community.

Although basic sanitation facilities are present, they are in disrepair. This is due to poor maintenance as well as inappropriate behaviour on the part of the users. These facilities do not last long as they are poorly maintained, however theft and vandalism from the community members can also contribute to the poor state of the facilities.

The survey confirmed that the sample population had a low income. Poverty causes low rates of payment for municipal services and this leads to poor service delivery. Poor service delivery means inadequate sanitation and waste disposal which leads to an unhygienic community running a high risk of infectious diseases. This is a vicious cycle of poverty as the more poor the community gets, the more polluted the environment becomes due to poor service delivery

and the more unhealthy the inhabitants get and the poorer they get as they are unable to work and provide for their families.

The study therefore concludes that the health sanitation status of people living in the low-income community of Mbekweni is poor. This is important to emphasise as good hygiene practices, proper sanitation, and housing infrastructure as well as adequate drinking water and waste management are important elements of promoting good health for the public.

4.2 Conclusions

- The study found support for the link between poor waste disposal and high environmental pollution. Symptoms of possible water-borne diseases were found, however the types of pathogens associated with such diseases were not directly linked to cases.
- The study revealed serious lack of adequate housing with frequent structural failures such as poor availability of washing and cleaning facilities (no on-site taps, basins, etc.), poor ventilation and inadequate roof structures. All these indicated that inadequate housing could result in more pathogen transmission routes.
- Both the municipality and the members of the community are responsible for preserving the functioning of the water and sanitation facilities. The community should learn to look after their facilities and the municipality should improve their co-operation with the community as well as drastically improve service delivery and the maintenance of the present infrastructure.
- Overcrowding was highly visible in this community with poor hygiene behaviour as documented. The health risks of cutting back on sanitation infrastructure and maintenance should be brought into decision making at municipal level.
- More specifically targeted waste management studies should be undertaken to fully understand the role and the drivers of improper waste disposal behaviour in this community.
- The findings of this study and future studies on poor sanitation and waste disposal can be extrapolated to many more low-income communities in South Africa that are in a

similar situation. High prevalence of disease can significantly impoverish already poor communities,

- Poor treatment of waste together with the poverty in the community opens great opportunities for recycling. For that to be realised, attention should be given to improving the processing of recycling inside the municipal area as well as the critical element of education for the community and the municipal officials involved.
- There are other links between low income and poor living conditions that have not been explored in the present study. Some of these possibilities include exposure to various diseases such as infection and food poisoning from poor food handling practices, diarrhoea, respiratory diseases from exposure to smoke from cooking and heating by open flames, pneumonia and TB, all of which have been shown to pose significant health risks.

4.3 Recommendations emanating from the findings of the study

The sanitation status of people living in the low-income community of Mbekweni is poor. The importance of efficient sanitation services has been emphasized above. This means that a fully functional toilet and tap should be allocated to people living in low-income communities.

Better management protocols need to be implemented to ensure that these communal toilets and taps are fully functional and are kept clean. As an interim measure until individual taps and toilets for each household can be afforded, supervision of the communal toilet blocks should be seriously considered. These supervisors can be recruited from the local community and easily trained as community-based care workers. Regular rotation of such workers will give many unemployed persons in the community a chance to do some paid work, while the rotation will prevent the formation of cliques or gangs of privileged persons given priority access to toilet facilities while others are denied access at the whim of the supervisor.

To promote good hygiene behavior an allocation for hand detergent and hand washing should be provided. This has been described as prioritisation of the implementation of the hand hygiene strategy as highlighted in the national hand hygiene behavior change strategy of South Africa.[146] It is however debatable whether this is financially viable over the long term.

The generation of waste is becoming problematic as seen from various illegal waste dumping sites within the community. It is therefore the community's responsibility as well as the local authorities' responsibility to better manage waste. The local municipality can start by ensuring that every household has a municipal bin and that the waste is collected on a regular basis. The residents can start practicing the reuse, recycle method so that they can work together with their local municipality in ensuring that waste is disposed of in a proper manner. This initiative will however come to a quick end if this is not coordinated properly by a local authority that is serious about the improvement of better waste services.

The methodology used and the findings of this study and future studies on poor sanitation and waste disposal should be extrapolated to many more low-income communities that are in a similar situation. High prevalence of disease can significantly impoverish already poor communities.

More specifically targeted waste management studies should be undertaken to fully understand the role and the drivers of improper waste disposal behaviour in this community.

Poor treatment of waste together with the poverty in the community opens great opportunities for recycling. For that to be realised, attention should be given to improving the processing of recycling inside the municipal area as well as the critical element of education for the community and the municipal officials involved. For the municipality to create sustainable living conditions and decrease environmental destruction, educational drives such as workshops should be implemented in this community to educate the residents on the ways they can practice recycling in their households. The local schools need to be more involved in recycling projects so that children can participate in keeping their neighborhood clean. The municipality is also urged to provide the community with the information to make them aware of the various health implications of poor hygiene, water, and sanitation as well as waste management.

Recycling is not just the collection of recyclable materials. Such materials have to be properly processed so that the materials can be reused again. For the idea of recycling to become a reality, it is imperative that more recycling plants be erected in the greater area of the Drakenstein Municipality. The distance that trucks need to travel to, for example, take glass for recycling to Cape Town, makes the recycling of glass totally uneconomic at present.

Therefore, many municipalities are reluctant to encourage recycling on a bigger scale since they soon run out of space to store the recyclable material that they are unable to get processed.

Education is key in eliminating various health challenges presented in public health. Educational awareness projects should be encouraged in Mbekweni community, these projects must focus on educating these residences in a manner that will be easy for them to understand about waste, sanitation and hygiene and the importance of these elements in minimizing communicable diseases. Basic workshops can be provided by the local authorities on the importance of cleanliness, proper waste disposal as well as adequate water and sanitation usage, these workshops will ensure the promotion of good health by preventing preventable communicable diseases. Educational posters can be placed all around the community as well as schools to encourage good health.

From this study it was observed that most of the respondents were aware basic knowledge that people can acquire diseases from improper sanitation, water and hygiene, but they lacked the knowledge of practical means to cope with the problems. They therefore had little motivation to take initiatives was taken to better their health. This is sometimes referred to in community health as "Knowing, but not doing."

Data from this project will allow for more individual awareness on waste disposal and risk of infectious diseases, as well as assist the government on waste management. Findings from this project may direct future research on the journey towards identifying the communicable disease threats faced by low-income communities and establishing effective methods for waste management as to ensure longevity of the population.

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ADDENDA

Appendix A: Participant information leaflet and consent form

TITLE OF THE RESEARCH PROJECT:

The health and sanitation status with an emphasis on waste disposal practices in a mixed housing community, Mbekweni in Paarl.

REFERENCE NUMBER: S15/09/195

PRINCIPAL INVESTIGATOR: Lerato Ngakane, MPhil candidate, Division of Community Health, Department of Interdisciplinary Health Sciences, Faculty of Medicine and Health Sciences, Tygerberg Campus, Stellenbosch University

ADDRESS: 2439 Phola Park
Mbekweni, Paarl

CONTACT NUMBER: 0781808709

You are invited to take part in a research project, kindly take some time and read through the information presented below as it will give you more details about this project. Please ask the principal investigator any questions about any part of this project that you do not fully understand. It is very important that you are fully satisfied and that you clearly understand what this research entails and how you could be involved. Also, your participation is **entirely voluntary,** and you are free to decline to participate. If you say no, this will not affect you negatively in any way whatsoever. You are also free to withdraw from the study at any point, even if you do agree to take part.

This study has been approved by the **Health Research Ethics Committee at Stellenbosch University** and will be conducted according to the ethical guidelines and principles of the international Declaration of Helsinki, South African Guidelines for Good Clinical Practice and the Medical Research Council (MRC) Ethical Guidelines for Research.

What is this research study all about?

This study will take place in Mbekweni community located in Paarl and the total number of participants will depend entirely on the number of willing candidates. This project aims to identity the waste disposal practices of this community and the effects waste can have to the environment and the health of the community. This will be done by interviewing willing participants and with their permission inspecting their household premises to identify the possible areas that can be changed to create a more environmental friendly and healthy community. The participants will remain anonymous as no personal details will be required from the participants and the consent form will be placed in a sealed box by the participants themselves.

Why have you been invited to participate?

Your area has been selected based on the subject we are investigating, but you the individual has been selected randomly so that we can ensure that we present the fairest possible data regarding the health status and the living conditions in and around your environment.

What will your responsibilities be?

To be very brave and answer the questions as honest as possible

Will you benefit from taking part in this research?

Yes, this study will present data that can be accessible to the local, provincial and national government, thereby aiding in the future planning for waste and sanitation infrastructure thereby improving the health status and environmental statuses of the community.

Are there in risks involved in your taking part in this research?

No, and you will remain anonymous

If you do not agree to take part, what alternatives do you have?

There are no other alternatives; you have the right not to conduct the interview or the right to stop the interview at any point in time when you are feeling uncomfortable.

Who will have access to your survey data?

We will group the responses provided by people living in the community, and therefore will be able to identify you from the data or information provided.

What will happen in the unlikely event of some form injury occurring as a direct result of your taking part in this research study?

The will be no form of injury occurring during this research as we only require you to answer certain questions and at any time during the interview, you are welcome to take a break if you feel too tired to answer any questions or you simply are dehydrated.

Will you be paid to take part in this study and are there any costs involved?

No, you will not be paid to partake in this study and there will be no costs involved for you, if you do take part.

Is there anything else that you should know or do?

You can contact Dr Thashlin Govender at tel. 082 646 6000 if you have any further queries or encounter any problems.

- You can contact the Health Research Ethics Committee at 021-938 9207 if you have any concerns or complaints that have not been adequately addressed by your study doctor.
- You will receive a copy of this information and consent form for your own records.

Declaration by participant

By signing below, I ……..……. agree to take part in a research study entitled *(*The health and sanitation status with an emphasis on waste disposal practices in a mixed housing community, Mbekweni in Paarl.

I declare that:

- I have read or had read to me this information and consent form and it is written in a language with which I am fluent and comfortable.

- I have had a chance to ask questions and all my questions have been adequately answered.
- I understand that taking part in this study is **voluntary** and I have not been pressurised to take part.
- I may choose to leave the study at any time and will not be penalised or prejudiced in any way.
- I may be asked to leave the study before it has finished, if the study doctor or researcher feels it is in my best interests, or if I do not follow the study plan, as agreed to.

Signed at (*place*) .....…..…….. On (*date*) ……...…….. 2016.

....

Signature of participant **Signature of witness**

Declaration by investigator

I *(name)* ……..…… declare that:

- I explained the information in this document to ……..
- I encouraged him/her to ask questions and took adequate time to answer them.
- I am satisfied that he/she adequately understands all aspects of the research, as discussed above
- I did/did not use an interpreter. (*If an interpreter is used then the interpreter must sign the declaration below.*

Signed at (*place*) .....…..…….. On (*date*) ……...…….. 2016.

....

Signature of investigator **Signature of witness**

Declaration by interpreter

I *(name)* ……..…… declare that:

- I assisted the investigator (*name*) ……. to explain the information in this document to (*name of participant*) ……..…….. using the language medium of Afrikaans/Xhosa.
- We encouraged him/her to ask questions and took adequate time to answer them.
- I conveyed a factually correct version of what was related to me.
- I am satisfied that the participant fully understands the content of this informed consent document and has had all his/her question satisfactorily answered.

Signed at (*place*) .....….....…….. On (*date*) ……...……..

....

Signature of interpreter **Signature of witness**

Appendix B: Study Questionnaire

My name is Lerato Ngakane. You are invited to take part in a research project carried out by the Medical Faculty of the University of Stellenbosch. We are going to be studying the waste generated by your home and the health of your family. Note that your participation in the study is voluntary and you may opt to leave the interview at any time. All answers and comments will be kept highly confidential. We will not record your name and we promise that no information you give us will be attached to you or anyone living in your home. Please do not hesitate to ask any questions that you may have with this study.

Section A: Demographics

A1	**What is the age of the respondent?**		**A2**	**What is the gender of the respondent?**	Male	Female
A3	**What is the marital status of the respondent?**	Married	Single	Widowed	If other, specify:	
A4	**How many people form part of this family and live in this home?**					
A5	**Can you share details of the people living in the home?**					
Person	**Role in household**	**Age**	**Gender**	What is the highest level (Grade 0-12) of education that this person has completed?	Status of individual U – Unemployed F – Full time employed P – Part time employed IRR – Irregular employment S – Scholar C – Child at home E – Elderly at home	
A6	**What is the total income of the home?**					
A7. **How many people in your home access a social grant?**						
A8	**Are members of the household South African citizens?**	Yes	No	If no, specify citizenship		

Section B: Domicile

B1. Type of home?	Brick and Mortar	Shack	Wooden house	If other, specify:	**B2. How many years have you lived in this home?**			
B3. Which best describes how you acquired your home?			Given to you by governm ent	Bought home	Built the home yourself	Inherited home	Rental	If other, specify:
B4	**When it rains does water come into your home?**					Yes	No	Unsure
B5	**Applicable to shack dwellers: Have you applied to council for a house?**					Yes	No	Unsure
B6	**Can you describe some of the structural things that are wrong with your home?**							

B7. Where is your toilet?	Inside the home	Outside the home	Communal toilet	**B8. The tap used to get water is located?**	Inside the home	Outside the home	Communal tap
B9. Do you have electricity in the home?	Yes	No	**If no, what do you use to cook?**	**B10 Do you pay for water?**	Yes	No	Sometimes
B11. Do you pay for electricity	Yes	No	Sometimes	**B12. Is the bathing area located**	Inside your home	Outside your home	No bathroom

Section C: Waste and waste disposal

I have the following questions about your kitchen		Yes	No	Unsure
C1	**Do you have a tap in your kitchen?**			
C2	**Do you have a sink in your kitchen?**			
C3	**Do you use a basin to wash up dishes?**			
C4	**Do you have a bin in your kitchen?**			
C5	**If there is a baby in the home, do you bath the baby in the kitchen sink?**			
C6	**Do you wash clothes in the kitchen sink?**			
C7	**After washing up dishes do you reuse the water in the house?**			
C8	**After washing up dishes do you use the water in your garden?**			
C9	**After washing up dishes do you use the water to wash the floors?**			
C10	**Can you afford to buy detergents (like sunlight soap) to wash your dishes?**			
C11	**Where do you throw kitchen, waste generated when cooking (such as meat fat, vegetable peels)**			
C12	**Do you throw used cooking oil down the kitchen sink?**			
C13	**Do you throw used cooking oil outside on the grass?**			
C14	**Do you flush used cooking oil down the toilet?**			
C15	**How often do you wash your dishes**	After every meal	Once a day	When needed

I have the following questions about your bathroom		Down the toilet	Down the drain	Outside, on the grass	Outside storm water drain
C16	**Where do you dispose of water after having a bath?**				
C17	**Where do you dispose of water after washing clothes?**				
C18	**Where do you dispose of water after cleaning your home?**				
C19	**Where do you dispose of water after washing floors?**				
C20	**If applicable, where do you dispose of water after washing nappies?**				
C21	**If applicable, where do you throw the water used to wash pets?**				
C22	**If applicable, where do you throw the water used to wash your car?**				
C23	**Where do you throw the water used to wash your reuse bin?**				

C24	**If applicable, where do you throw baby nappies?**						
C25	**How do you dispose of broken glass?**						
C26	**How do you dispose of furniture?**						
C27	**How do you dispose of old medication?**						
C28	**How do you dispose of garden waste?**						
C29	**How do you dispose of animal (pet) waste?**						
C30	**How do you dispose of unwanted items?**						
C31	**Does the municipality come collect rubbish**	Yes	No	**C32**	**Do you dump dirt on a local dump site?**	Yes	No
C33	**Do you burn dirt?**	Yes	No	**C34**	**Do you recycle waste?**	Yes	No

Section D: Health and Hygiene

D1	**Which health facility do you use when sick**		Local clinic	Private GP	Traditional healer	Public hospital	Other, if so specify:	
D2	**How do you get to the health facility?**	Walk	Taxi	Bus	Own car	Train	Other, if so specify:	
D3	**How much does it cost you to get to the health facility?**							
D4	**Has anyone in the household been diagnosed with TB?**					Yes	No	Unsure
D5	**Has anyone in the household been diagnosed with HIV?**					Yes	No	Unsure
D6	**Has anyone in the household been hospitalised in the last 6 months?**					Yes	No	Unsure
D7	**Have you ever called for an ambulance?**					Yes	No	Unsure
D8	**Do you feel that the medication given by the clinic/government works?**					Yes	No	Unsure
D9	**When given medication do you finish the medication as indicated by the health professional?**					Yes	No	Unsure
D10	**Has anyone in your household suffered from the following in the last two weeks?**							
D11	**Diarrhoea**					Yes	No	Unsure
D12	**Fever**					Yes	No	Unsure
D13	**Vomiting**					Yes	No	Unsure
D14	**Cramps/ Abdominal pain**					Yes	No	Unsure
D15	**Eye infection**					Yes	No	Unsure
D16	**Headaches**					Yes	No	Unsure
D17	**Coughing blood**					Yes	No	Unsure
D18	**Itchy skin**					Yes	No	Unsure
D19	**Nausea**					Yes	No	Unsure
D20	**Coughing for longer than two weeks**					Yes	No	Unsure
D21	**Loss of appetite**					Yes	No	Unsure
D22	**Loss of weight**					Yes	No	Unsure
D23	**Night sweats**					Yes	No	Unsure

D24	**Do you wash your hands after using the bathroom?**	Yes	No	Unsure
D25	**Do you think you can get sick from using a dirty toilet?**	Yes	No	Unsure
D26	**Do you think you can get sick from living in a dirty home?**	Yes	No	Unsure
D27	**Do you think you can get sick from dirt/rubbish being outside your home?**	Yes	No	Unsure
D28	**Do you think you can get sick from drinking water from the river?**	Yes	No	Unsure
D29	**Do you think you can get sick from playing in the nearby river?**	Yes	No	Unsure
D30	**Is it difficult to keep your home clean?**	Yes	No	Unsure
D31	**Can you afford to buy soap for washing hands?**	Yes	No	Unsure
D32	**Can you afford to buy soap for bathing?**	Yes	No	Unsure
D33	**How often do you bath the children?**	Once a day	Twice a day	When needed
D34	**How often do you bath?**	Once a day	Twice a day	When needed
D35	**Are there lots of rats in the yard?**	Yes	No	Unsure
D36	**Are there any cockroaches in your home?**	Yes	No	Unsure
D37	**Do you have any flies in your home?**	Yes	No	Unsure

Notes:

Appendix C.1: Study checklist

Survey Number:					
		Circle the right answer			Comments
1	The type of dwelling	Main dwelling	Shack in backyard	other	
2	Is the house neatly maintained?	Poor	Fair	Good	
3	Are there any large cracks in the walls?	Yes	No		
4	Does the house have electricity?	Yes	No		
5	Is the roof of the house leaking?	Yes	No		
6	Are there any broken windows in the house	Yes	No		
7	Is the bathroom clean	Yes	No		
8	Can the toilet flush properly?	Yes	No		
9	Is the toilet leaking?	Yes	No		
10	Are the taps in good working condition?	Yes	No		
11	Is there toilet paper in bathroom?	Yes	No		
12	Is there soap in the bathroom to wash the hands?	Yes	No		
13	Is there a clean towel or paper towels in the bathroom?	Yes	No		
14	Is there a drain nearby?	Yes	No		
15	Is the drain clean?	Yes	No		
16	Are there any structural damages to the home?	Yes	No		
17	Are there any structural changes or extensions to the home?	Yes	No		
18	What is the state of the yard outside the home?	Poor	Fair	Good	
19	Is there a bin inside the home?	Yes	No		
20	Is there a bin outside the home?	Yes	No		

21	**Is there a garden outside the house?**	**Yes**	**No**		
22	**Is rubbish visible outside the home?**	**Yes**	**No**		
23	**Are there pools of water outside the home?**	**Yes**	**No**		
24	**Does the family own pets/animals?**	**Yes**	**No**		
25	**Is there any animal waste outside the home?**	**Yes**	**No**		
26	**Does the home have electricity? If yes, is it obtained legally?**	**Yes**	**No**	**Legal**	**Illegal**
27	**Does the home have an operating refrigerator?**	**Yes**	**No**		
28	**Does the home use an electrical stove?**	**Yes**	**No**		
29	**Is there evidence of other forms of heating/lightning**	**Yes**	**No**		
30	**Does the family own a car**	**Yes**	**No**		
31	**Are there any bin plastic bags inside the bins of the house?**	**Yes**	**No**		
32	**Are there any broken glasses visible outside the home?**	**Yes**	**No**		

Appendix C.2: Study Checklist observation

	Checklist question numbers									
Survey No	S1	S2.1	S2.2	S4	S5.2	S6.1	S7	S8.2
1	MD	MD	SIY	MD	SIY	MD	SIY	SIY
2	Good	Fair	Poor	Good	Good	Fair	Poor	Poor
3	No	Yes	Yes	No	No	Yes	No	No
4	Yes	Yes	No	No	No	No	No	Yes
5	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
6	No	No	Need windows	No	No	No	No	Need windows
7	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
8	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
9	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
10	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
11	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
12	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
13	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
14	Yes	Yes	Yes	Yes	Yes	No	No	Yes
15	No(very dirty)	No(very dirty)	No(very dirty)	No(very dirty)	No(very dirty)	N/A	N/A	No
16	No	Yes	Yes	No	No	Yes	No	Yes
17	No	No	No	No	No	Yes	No	No
18	Good	Fair	Poor	Fair	Fair	Fair	Poor	Poor
19	No	No	No	No	No	No	No	No
20	No	No (Plastic)	No (Plastic)	No (Plastic)	No (Plastic)	Yes	No	Yes
21	Yes. (small)	No	No	No	No	No	No	No
22	No	No	No (behind	No	No	A little	A little	Yes
23	No	No	No	No	No	No	No	No
24	No	No	No	No	No	No	No	No
25	No	No	No	No	No	No	No	No
26	Illegal	Illegal	Illegal	Illegal	Illegal	No	No	Illegal
27	Yes	No	No	No	Yes	No	No	No
28	Yes	No (Gas)	No(Paraffin)	No (Gas)	No (Gas)	No(Flame)	No (Flame)	No (Flame)
29	No	No	No	No	Yes (Fan)	No	No	No
30	No	No	No	No	Yes	No	No	No
31	No	No	No	No	No	No	No	No
32	No	No	No	No	No	No	No	No

W16	S15	S14	H13	W12	S11.2	S11.1	S10	S9	S8.3
MD	SIY	SIY	MD	MD	SIY	MD	MD	MD	SIY
Fair	Fair	Fair	Good	Fair	Fair	Good	Good	Good	Fair
No	No	No	Yes	No	No	No	No	No	No
Yes	No	No	Yes	Yes	Yes	Yes	Yes	Yes	No
Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
No	No	No	No	No	No	No	No	No	Need windows
N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Yes	Yes	N/A	Yes	N/A	N/A	N/A	N/A	N/A	N/A
No	No	N/A	No	N/A	N/A	N/A	N/A	N/A	N/A
Yes	Yes	N/A	Yes	N/A	N/A	N/A	N/A	N/A	N/A
No	No	N/A	Yes	N/A	N/A	N/A	N/A	N/A	N/A
N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
No	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
N/A	No	No	No	No	No	No	N/A	No	No
No	Yes	Yes	Yes	No	Yes	Yes	No	No	Yes
No	No	No	No	No	No	No	No	No	No
Fair	Fair	Fair	Good	Fair	Fair	Good	Good	Good	Fair
No	No	No	No	No	No	No	No	No	No
Yes	Yes	Yes	Yes	No	No	No	Yes	Yes	No
No	No	No	No	No	Yes, (new,	No	No	No	No
No	No	No	No	No	No	No	No	No	No
No	No	No	No	No	No	No	No	No	Yes
No	Yes	No	No	Yes	Yes	No	No	No	No
N/A	No	No	No	No	No	No	No	No	No
Illegal	Illegal	Illegal	Legal	Illegal	Illegal	Illegal	Illegal	Illegal	N/A
Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	No
No	No	No	No	No	No	No	No	No	No
No	No	No	No	No	No	No	No	No	No
No	No	No	No	No	No	No	No	No	No
No	No	No	No	No	No	No	No	No	No

H26	S25	S24	H23	S22	S21	H20	H19	S18	S17
MD	SIY	SIY	MD	SIY	SIY	MD	MD	SIY	SIY
Good	Poor	Poor	Good	Fair	Fair	Good	Fair	Poor	Fair
No	Yes	Yes	Yes	No	No	No	Yes	No	No
Yes	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
No	Yes	Yes	Yes	Unsure	No	No	Yes	Yes	Yes
No	No	No	Yes	No	No	No	No	No	No
N/A	N/A	N/A	N/A	N/A	N/A	Yes	Yes	N/A	N/A
Yes	N/A	N/A	Yes	N/A	N/A	YEs	Yes	N/A	N/A
No	N/A	N/A	No	N/A	N/A	No	No	N/A	N/A
Yes	N/A	N/A	Yes	N/A	N/A	Yes	Yes	N/A	N/A
No	N/A	N/A	No	N/A	N/A	Yes	Yes	N/A	N/A
No	N/A	N/A	No	N/A	N/A	No	No	N/A	N/A
No	N/A	N/A	No	N/A	N/A	No	No	N/A	N/A
No	Yes	No	No	Yes	Yes	No	No	No	Yes
N/A	No	N/A	N/A	No	No	N/A	N/A	N/A	No
No	No	Yes	Yes	No	No	No	Yes	No	No
No	No	No	No	No	No	No	No	No	No
Good	Poor	Fair	Fair	Fair	Fair	Good	Fair	Poor	Fair
No	Yes	No	No	No	No	No	No	No	No
Yes	No	No	Yes	Yes	Yes	Yes	Yes	No	Yes
No	No	No	No	No	No	No	No	No	No
No	Yes	No	No	A little	No	No	No	Yes	No
No	No	No	No	No	No	No	No	No	No
No	No	No	Yes	No	No	No	No	No	No
No	No	No	No	No	No	No	N/A	N/A	N/A
Legal	No	No	Legal	Illegal	Legal	Legal	Legal	Illegal	Illegal
Yes	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Yes	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	No	No
No	No	No	No	No	No	No	No	No	No
No	No	No	No	No	No	No	No	No	No
No	No	No	No	No	No	No	No	No	No

S36	S35	S34	S33	S32	S31	S30	H29	S28	S27
SIY	SIY	SIY	SIY	SIY	SIY	SIY	MD	SYI	SIY
Fair	Fair	Good	Fair	Poor	Poor	Fair	Fair	Fair	Fair
Yes	Yes	No	No	Yes	Yes	Yes	Yes	No	No
Yes	No	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes
Yes	Yes	Yes	Yes	N/A	No	Yes	Yes	Yes	Yes
can't close	Need windows	No	No	No	No	No	No	No	No
N/A	N/A	N/A	N/A	N/A	N/A	N/A	Yes	N/A	N/A
N/A	N/A	N/A	N/A	N/A	N/A	N/A	Yes	N/A	N/A
N/A	N/A	N/A	N/A	N/A	N/A	N/A	No	N/A	N/A
N/A	N/A	N/A	N/A	N/A	N/A	N/A	Yes	N/A	N/A
N/A	N/A	N/A	N/A	N/A	N/A	N/A	No	N/A	N/A
N/A	N/A	N/A	N/A	N/A	N/A	N/A	No	N/A	N/A
N/A	N/A	N/A	N/A	N/A	N/A	N/A	No	N/A	N/A
No	Yes	Yes	No	Yes	No	No	No	No	Yes
N/A	No	No	N/A	No	N/A	N/A	N/A	N/A	No
Yes	Yes	Yes	No	No	Yes	Yes	Yes	Yes	Yes
No	No	No	No	No	No	No	No	No	No
N/A	Fair	Good	Fair	Poor	Poor	Poor	Fair	Fair	Fair
No	No	No	No	No	No	No	No	No	No
No	No	Yes	No	No	No	No	Yes	No	Yes
No	No	Yes	No	No	No	N/A	No	No	No
No	Yes	No	No	Yes	Yes	Yes	No	Yes	No
No	Yes	No	No	No	No	No	No	No	No
No	No	No	No	No	N/A	N/A	No	No	No
No	No	No	N/A	N/A	N/A	No	No	No	No
Illegal	No	Legal	No	Illegal	Illegal	Illegal	Legal	Illegal	Illegal
No	No	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes
Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes
No	Yes	No	Yes	No	No	No	No	No	No
No	No	No	No	No	No	No	No	No	No
No	No	No	No	No	No	No	No	No	No
No	No	No	No	No	No	No	No	No	No

H46	H45	H44	S43	H42	H41	H40	S39	S38	S37
MD	MD	MD	SIY	MD	MD	MD	SIY	SIY	SIY
Fair	Good	Fair	Good	Good	Good	Fair	Fair	Poor	Good
No	No	No	No	No	Yes	No	No	Yes	No
Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
No	No	no	No	No	No	No	Yes	Yes	No
No	No	No	No	No	No	No	No	Need windows	No
N/A	Yes	Yes	N/A	N/A	N/A	Yes	N/A	N/A	N/A
Yes	Yes	Yes	Yes	Yes	Yes	Yes	N/A	N/A	N/A
No	No	No	No	No	No	No	N/A	N/A	N/A
Yes	Yes	yes	Yes	Yes	Yes	Yes	N/A	N/A	N/A
Yes	Yes	No	No	Yes	Yes	No	N/A	N/A	N/A
No	No	No	M/A	N/A	No	No	N/A	N/A	N/A
N/A	No	No	N/A	N/A	No	No	N/A	N/A	N/A
No	Yes	No	No	No	No	No	No	No	No
N/A	No	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
No	No	No	No	No	Yes	No	Yes	Yes	Yes
No	No	No	No	No	No	No	Yes	Yes	Yes
Fair	Good	Fair	Good	Good	Fair	Fair	Poor	Fair	Fair
No	No	No	No	Yes	No	No	No	No	No
Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No	Yes
Yes	Yes	No	No	No	No	No	No	No	No
No	No	No	No	No	No	No	Yes	No	No
No	No	No	No	No	No	No	Yes	No	No
Yes	No	No	No	No	No	No	No	No	No
No	N/A	N/A	N/A	N/A	No	No	No	No	N/A
Legal	Legal	Legal	Legal	Legal	Legal	Legal	Illegal	Illegal	Illegal
Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
No	No	No	No	No	No	No	No	No	No
No	N/A	N/A	No	Yes	No	No	No	No	No
No	No	No	No	No	No	No	No	No	No

H56	H55	H54	H53	H52	H51	H50	H49	H48	H47
MD	MD	MD	MD	MD	MD	MD	MD	MD	MD
Fair	Good	Fair	Good	Poor	Fair	Good	Fair	Fair	Poor
Yes	No	No	Yes	Yes	No	No	Yes	Yes	Yes
Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No	No
Yes	No	N o	Yes	Yes	No	No	No	No	Yes
No	No	No	No	No	No	No	N/A	No	No
Yes	Yes	N/A	N/A	No	Yes	Yes	Yes	Yes	N/A
Yes	Yes	No	Yes	Yes	Yes	Yes	No	No	Yes
No	No	No	No	No	No	No	Yes	Yes	No
Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
Yes	Yes	N/A	N/A	Yes	Yes	Yes	N/A	No	No
No	Yes	N/A	N/A	No	No	No	N/A	No	N/A
No	No	N/A	N/A	No	No	No	N/A	No	N/A
No	No	Yes	No	No	No	No	No	No	No
N/A	N/A	No	N/A	N/a	N/A	N/A	N/A	N/A	N/A
No	No	No	Yes	Yes	No	No	No	No	Yes
No	Yes	Yes	No	No	No	Yes	No	Yes	No
Good	Good	Fair	Good	Poor	Fair	Good	Fair	Fair	Fair
No	Yes	No	No	No	No	Yes	No	No	No
Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
No	Yes	No	Yes	Yes	No	No	No	No	No
No	No	No	No	No	No	No	No	No	Yes
No	No	No	No	Yes	No	No	No	No	No
No	No	No	Yes	No	No	No	No	No	No
N/A	N/A	N/A	No	N/A	N/A	N/A	N/A	N/A	N/A
Legal	Legal	Legal	Legal	Legal	Legal	Legal	Legal	Legal	Legal
Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
No	Yes	No	No	No	Yes	Yes	Yes	Yes	No
No	No	No	No	No	No	Yes	Yes	No	No
N/A	Yes	N/A	N/A	N/A	N/A	Yes	No	No	No
No	No	No	No	No	No	No	No	No	No

S66	H65	S64	S63	H62	H61	H60	H59	H58	H57
SIY	Rental	SIY	SIY	MD	MD	MD	MD	MD	MD
Poor	Fair	Fair	Fair	Fair	Good	Good	Good	Poor	Poor
Yes	No	Yes	No	No	Yes	No	No	Yes	Yes
Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Yes	No	Yes	No	Yes	Yes	No	No	Yes	No
Yes	No	No	No	Yes	Yes	No	No	No	No
N/A	Yes	N/A	N/A	Yes	Yes	Yes	Yes	Yes	No
N/A	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N/A	No	Yes	No	No	No	No	No	No	No
No	Yes	No	Yes	No	Yes	Yes	No	Yes	No
No	Yes	No	No	Yes	Yes	Yes	Yes	No	No
No	Yes	No	N/A	Yes	Yes	Yes	No	No	No
N/A	Yes	Yes	N/a	No	Yes	Yes	No	No	No
Yes	No	No	Yes	Yes	No	No	Yes	No	Yes
No	N/A	Yes	no	No	N/a	N/A	No	N/A	No
Yes	No	Yes	No	Yes	No	No	No	Yes	Yes
Yes	No	Yes	No	No	Yes	Yes	No	No	No
Poor	Good	Poor	Good	Fair	Good	Good	Good	Fair	Fair
No	Yes	No	No	Yes	Yes	Yes	Yes	No	No
No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
No	No	No	No	Yes	No	No	No	No	No
Yes	No	Yes	No	No	No	No	No	No	No
No	No	Yes	No	No	No	No	No	No	Yes
No	No	No	No	Yes	Yes	Yes	No	No	No
N/A	No	Yes	N/A	No	No	No	N/A	N/A	N/A
Illegal	Legal	Illegal	Legal	Legal	Legal	Legal	Legal	Legal	Legal
Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
No	Yes	Yes	No	Yes	Yes	Yes	Yes	No	No
No	Yes	No	No	No	Yes	Yes	No	No	No
N/A	Yes	No	N/A	Yes	Yes	Yes	Yes	N/A	N/A
No	No	Yes	No	No	No	No	No	No	No

H76	H75	S74	H73	S72	H71	S70	S69	S68	H67
MD	MD	SIY	MD	SIY	MD	SIY	SIY	SYI	MD
Fair	Fair	Fair	Good	Poor	Fair	Fair	Fair	Poor	Fair
No	No	No	No	Yes	No	Yes	No	No	No
Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Yes	Yes	Yes	No	Yes	Yes	Yes	No	Yes	No
No	No	No	No	No	No	No	Yes	No	No
Yes	Yes	N/A	Yes	No	Yes	N/A	N/A	N/A	Yes
No	No	No	Yes	No	Yes	No	Yes	N/A	Yes
Yes	Yes	Yes	No	Yes	No	Yes	No	N/A	No
Yes	No	No	Yes	No	Yes	No	Yes	N/A	Yes
No	Yes	No	Yes	No	Yes	No	Yes	N/A	Yes
No	No	No	Yes	No	Yes	No	No	N/A	No
No	Yes	No	Yes	No	No	No	No	N/A	No
Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	No
No	No	No	Yes	No	No	No	No	No	No
Yes	Yes	Yes	No	Yes	Yes	Yes	No	Yes	No
Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	No
Fair	Poor	Fair	Good	Fair	Fair	Poor	Good	Fair	Poor
No	No	No	No	No	No	Yes	No	No	No
Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	No	Yes
No	No	No	Yes	No	No	No	No	No	No
Yes	No	No	No	No	Yes	Yes	No	No	No
Yes	No	No	No	No	No	No	No	No	No
No	Yes	No	No	No	No	No	No	No	No
Yes	No	N/A	No	No	N/A	N/A	Yes	N/A	No
Legal	Legal	Legal	Legal	Legal	Legal	Illegal	Legal	Illegal	Legal
Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	No	Yes
No	Yes	Yes	Yes	Yes	No	Yes	Yes	No	Yes
Yes	Yes	No	Yes	No	Yes	Yes	No	Yes	Yes
No	No	No	Yes	No	No	No	No	No	No
No	No	N/A	No	No	N/A	N/A	N/A	N/A	No
Yes	No	No	No	No	No	No	No	No	No

S86	H85	S84	H83	S82	H81	S80	H79	H78	S77
SIY	MD	SIY	MD	SIY	MD	SIY	MD	MD	SIY
Poor	Fair	Fair	Fair	Fair	Fair	Poor	Good	Fair	Fair
No	Yes	No	No	No	No	No	Yes	Yes	No
No	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	No
No	No	No	No	No	No	Yes	Yes	No	No
No	No	No	No	No	No	N/A	No	No	No
N/A	Yes	N/A	Yes	N/A	Yes	No	Yes	N/A	N/A
No	Yes	No	Yes	No	Yes	Yes	Yes	Yes	No
Yes	No	N/A	No	Yes	No	Yes	Yes	No	Yes
No	Yes	Yes	Yes	No	Yes	No	Yes	Yes	No
No	No	No	Yes	No	Yes	No	Yes	Yes	No
No	No	No	Yes	No	No	No	No	No	No
No	No	No	Yes	No	No	No	No	No	No
Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
No	No	No	Yes	No	No	No	Yes	Yes	Yes
Yes	Yes	Yes	No	Yes	Yes	No	Yes	No	No
Yes	Yes	Yes	No	Yes	Yes	No	Yes	No	No
Poor	Poor	Fair	Fair	Fair	Fair	Poor	Poor	Fair	Fair
No	Yes	No	Yes	No	Yes	No	Yes	No	No
No	Yes	No	Yes	No	Yes	No	Yes	Yes	Yes
No	No	No	No	No	Yes	No	No	No	No
Yes	Yes	Yes	No	Yes	No	Yes	No	No	Yes
Yes	No	Yes	No	Yes	No	No	No	No	No
No	Yes	No	No	No	No	No	No	No	No
Yes	No	Yes	No	Yes	No	Yes	Yes	No	No
Illegal	Legal	Illegal	Legal	Illegal	Legal	Illegal	Legal	Legal	Illegal
No	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	No
No	Yes	Yes	Yes	Yes	Yes	No	Yes	No	No
No	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	No
No	No	No	Yes	Yes	No	No	No	No	No
No	Yes	No	No	No	No	No	No	No	No
No	Yes	Yes	No	Yes	No	Yes	No	No	Yes

S96	H95	S94	H93	S92	S91	S90	H89	S88	H87
SIY	MD	SIY	MD	SIY	SIY	SIY	MD	SIY	MD
Poor	Fair	Fair	Good	Poor	Fair	Fair	Good	Poor	Good
No	No	No	No	No	Yes	No	No	No	Yes
No	Yes	No	Yes	No	Yes	No	Yes	No	Yes
Yes	No	Yes	No	No	Yes	No	No	No	No
No	Yes	No	No	No	No	No	No	No	No
N/A	Yes	N/A	Yes	N/A	N/A	N/A	Yes	N/A	Yes
No	Yes	No	Yes	No	Yes	No	Yes	No	Yes
Yes	No	Yes	No	Yes	No	No	No	Yes	No
No	Yes	No	Yes	No	Yes	No	Yes	No	Yes
No	No	No	Yes	No	No	No	Yes	No	Yes
No	No	No	Yes	No	No	No	No	No	Yes
No	No	No	Yes	No	Yes	Yes	No	No	Yes
Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes
No	No	No	Yes	No	Yes	No	Yes	No	Yes
No	No	No	No	No	No	No	No	No	No
No	No	No	No	No	No	No	No	No	No
Poor	Poor	Fair	Fair	Poor	Fair	Fair	Poor	Good	Good
No	Yes	No	No	No	No	No	Yes	No	Yes
No	Yes	No	Yes	No	Yes	No	Yes	No	Yes
No	No	No	No	No	No	No	Yes	No	No
Yes	Yes	Yes	No	Yes	Yes	Yes	No	Yes	No
No	No	No	No	Yes	No	Yes	No	No	No
No	No	No	Yes	No	No	No	No	No	Yes
Yes	Yes	Yes	No	Yes	Yes	Yes	No	Yes	No
Illegal	Legal	Illegal	Legal	Illegal	Illegal	Illegal	Legal	Illegal	Legal
No	Yes	No	Yes	No	No	No	Yes	No	Yes
No	Yes	No	Yes	No	Yes	No	Yes	No	Yes
No	Yes	No	Yes	No	Yes	Yes	Yes	No	Yes
No	Yes	No	No	No	No	No	No	No	Yes
No	Yes	No	No	No	No	No	No	No	Yes
Yes	No	Yes	No	Yes	Yes	Yes	No	Yes	No

H106	H105	W104	H103	S102	S101	S100	H99	S98	H97
MD	MD	MD	MD	SIY	SIY	SIY	MD	SIY	MD
Poor	Fair	Fair	Good	Fair	Poor	Fair	Good	Poor	Fair
Yes	No	Yes	No	No	No	No	No	No	No
Yes	Yes	Yes	No	No	Yes	Yes	Yes	No	Yes
Yes	No	Yes	No	No	No	Yes	No	Yes	No
No	No	No	No	No	No	No	No	No	No
Yes	Yes	N/A	Yes	N/A	N/A	N/A	Yes	N/A	Yes
Yes	Yes	N/A	Yes	No	Yes	No	Yes	No	Yes
No	No	N/A	No	Yes	Yes	Yes	Yes	No	No
Yes	Yes	N/A	Yes	No	Yes	No	Yes	No	Yes
Yes	No	N/A	Yes	No	Yes	No	Yes	No	Yes
No	No	N/A	Yes	No	No	No	Yes	No	Yes
No	No	N/A	Yes	No	No	No	No	No	Yes
No	No	Yes	No	Yes	Yes	Yes	Yes	Yes	No
N/A	N/A	No	N/A	No	Yes	No	No	No	Yes
Yes	No	Yes	No	No	No	No	Yes	No	No
No	No	No	No	No	No	No	No	No	No
Fair	Fair	Poor	Fair	Fair	Fair	Fair	Good	Poor	Fair
No	No	No	No	No	No	No	Yes	No	No
Yes	Yes	No	Yes	No	Yes	No	Yes	No	Yes
No	No	No	No	No	No	No	Yes	No	Yes
No	No	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes
No	No	Yes	No	Yes	Yes	Yes	No	No	No
No	Yes	No	No	No	No	No	No	No	Yes
N/A	Yes	No	No	Yes	No	Yes	No	Yes	Yes
Legal	Legal	Illegal	Legal	Illegal	Legal	Legal	Legal	Illegal	Legal
Yes	Yes	Yes	Yes	No	No	Yes	Yes	No	Yes
Yes	Yes	Yes	Yes	No	No	Yes	Yes	No	Yes
Yes	No	No	Yes	No	Yes	Yes	Yes	No	Yes
No	No	No	No	No	Yes	No	Yes	No	Yes
No	No	No	No	No	No	No	Yes	No	No
No	No	No	No	Yes	No	Yes	No	Yes	Yes

H116	H115	H114	H113	S112	W11	H110	W109	H108	H107
MD	MD	MD	MD	SIY	SIY	MD	SIY	MD	MD
Good	Good	Fair	Fair	Good	Good	Good	Fair	Good	Poor
No	Yes	Yes	Yes	No	Yes	No	No	No	Yes
Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
No	No	No	Yes	No	Yes	No	Yes	No	Yes
No	No	No	Yes	No	No	No	No	No	No
Yes	Yes	N/A	No	N/A	N/A	Yes	N/A	Yes	Yes
Yes	Yes	Yes	Yes	N/A	Yes	Yes	N/A	Yes	Yes
No	No	No	No	N/A	No	Yes	N/A	Yes	No
Yes	Yes	Yes	Yes	N/A	Yes	Yes	N/A	Yes	Yes
No	Yes	No	Yes	N/A	No	Yes	N/A	Yes	Yes
No	Yes	No	No	N/A	No	No	N/A	No	No
No	No	No	No	N/A	No	No	N/A	No	No
No	Yes	No	No	Yes	Yes	No	Yes	Yes	Yes
N/A	No	N/A	N/A	No	No	N/A	No	No	No
No	No	Yes	No	No	No	No	No	No	Yes
Yes	No	No	No	No	No	No	No	No	No
Good	Fair	Fair	Good	Poor	Fair	Fair	Poor	Fair	Fair
No	Yes	No	No	No	No	Yes	No	No	No
Yes	Yes	Yes	Yes	No	Yes	Yes	No	Yes	Yes
Yes	Yes	No	No	No	Yes	No	No	No	No
No	No	No	No	Yes	No	No	No	No	No
No	No	No	No	No	No	No	Yes	No	No
Yes	Yes	No	Yes	No	No	No	No	No	No
No	No	N/A	No	No	N/A	No	No	No	N/A
Legal	Legal	Legal	Legal	Illegal	Legal	Legal	Illegal	Legal	Legal
Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes
Yes	Yes	Yes	Yes	No	No	Yes	No	Yes	No
No	Yes	No	Yes	No	No	No	No	No	No
N/A	Yes	No	N/A	No	No	Yes	No	No	No
No	No	No	No	No	No	No	No	No	No

H117	MD	Fair	Yes	Yes	Yes	No	Yes	Yes	No	Yes	Yes	No	No	Yes	No	Yes	No	Fair	No	Yes	Yes	No	No	No	N/A	Legal	Yes	Yes	Yes	Yes	N/A	No

Appendix D: Questions about the kitchen

Questions about the kitchen		Yes (%)	No (%)	N/A (%)
C1	Do you have a tap in your kitchen?	47	53	
C2	Do you have a sink in your kitchen?	43	57	
C3	Do you use a basin to wash up dishes?	61	39	
C4	Do you have a bin in your kitchen?	37	63	
C5	If there is a baby in the home, do you bath the baby in the kitchen sink?	5	70	25
C6	Do you wash clothes in the kitchen sink?	3	83	15
C7	After washing up dishes do you reuse the water in the house?	5	95	
C8	After washing up dishes do you use the water in your garden?	6	82	12
C9	After washing up dishes do you use the water to wash the floors?	9	91	
C10	Can you afford to buy detergents (like sunlight soap) to wash your dishes?	8	92	
C11	Where do you throw kitchen, waste generated when cooking (such as meat fat, vegetable peels)			
C12	Do you throw used cooking oil down the kitchen sink?	10	74	16
C13	Do you throw used cooking oil outside on the grass?	18	82	
C14	Do you flush used cooking oil down the toilet?	19	81	
C15	How often do you wash your dishes	After every meal	Once a day	When needed

Appendix F: Photographs from study site

Photograph 1: A photograph showing various members of the community. Some members are doing their laundry while kids from other households are sent to collect water in a bucket.

Photograph 2: Illegal waste dumping site next to communal toilet and resident's laundry

Photograph 3: Communal toilets with broken doors and water coming out, communal tap a few minutes away where children are collecting water and illegal waste dump site

Photograph 4: Wastewater puddles on the streets and resident walking to fetch water that is located near the illegal waste dump site and communal toilet

Photograph 5: Communal Toilets surrounded by long grass

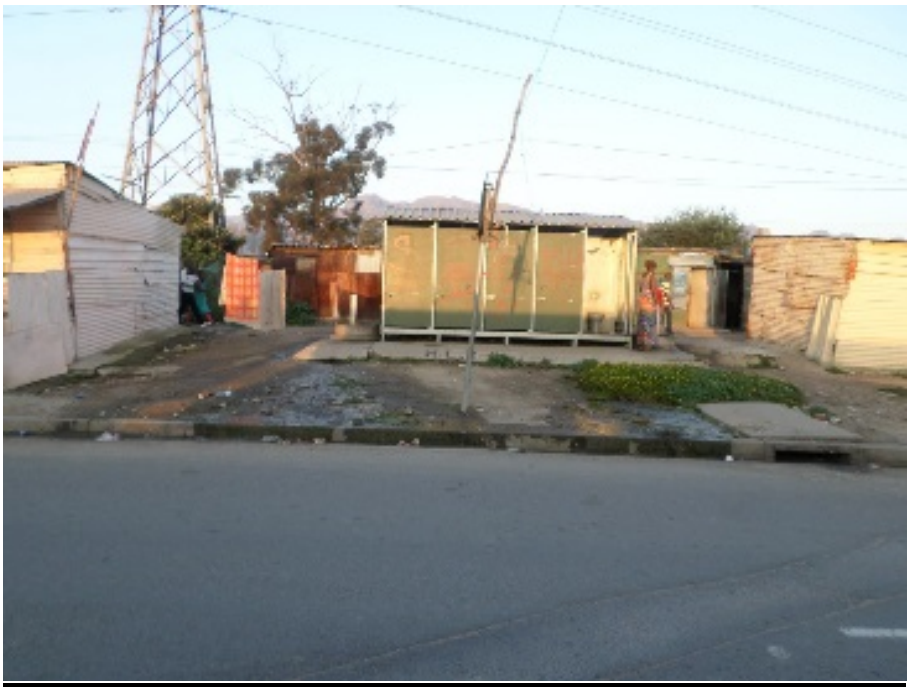
Photograph 6: Blocked storm water drain in the informal settlements

Photograph 7: A photograph showing the housing conditions after a rainy day

Photograph 8: Shacks surrounded by stormwater

Photograph 9: A photograph showing how people dry their clothes after doing laundry.

Photograph 10: Communal taps, toilets and community laundry, water flowing into the streets.



Photograph 11: Communal Toilet, taps located amongst shacks

Photograph 12: Communal toilets with broken doors and in a flooded state.

Photograph 13: Communal toilet condition

Photograph 14: Waste near shacks

Photograph 15: Illegal waste dump site behind shacks

Photograph 16: Illegal waste dump site near the train station

Photograph 17: Various shacks located in one area

Photograph 18: Communal tap not working properly and surrounded by pollution

Photograph 19: A resident collecting water at the communal site, a single tap surrounded by water puddles and illegally dumped waste

Photograph 20: children playing next to the dirty water

Photograph 21: A pig bin located between shacks